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Power Generation in a Pie Bakery

RECONSTRUCTED POWER PLANT OF CASE & MARTIN CO. EMPLOYED TO MEET DIVERSIFIED REQUIREMENTS; ELECTRIC VEHICLE CHARGING CURRENT CONSTITUTES LARGE SHARE OF LOAD AND MATERIALLY IMPROVES LOAD FACTOR

IN ORDER TO MEET the demands of a rapidly growing business, it became necessary, about a year ago, for the Case & Martin Co. of Chicago, reputed to be the largest exclusive pie bakery in the country, with an approximate capacity of 30,000 pies a day, to make radical changes in its power-production equipment so that at the present time is has one of the most modern, compact and efficiently operated power plants of its type. For its rated capacity, the space occupied is exceedingly small, each available square foot of floor space and even overhead room being utilized to good advantage.

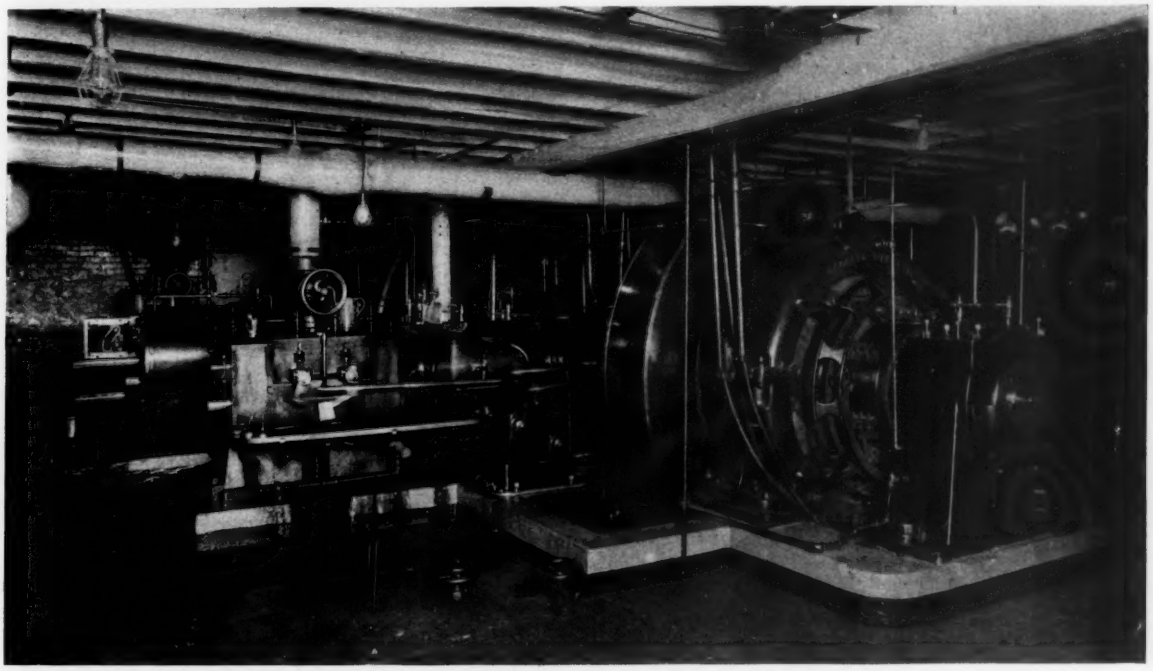


FIG. 1. SOUTH END OF ENGINE ROOM SHOWING RECENTLY INSTALLED UNITS

FUEL AND WATER SUPPLY

THE COAL FIRED, which ordinarily is bituminous, having an average heat value of about 11,500 B.t.u. per pound, is delivered by trucks and discharged into a 38-ton wooden hopper from which it falls onto the floor of the boiler room whence it is shoveled by hand into the furnaces or stokers as the case may be.

Ashes are also removed by hand from the pits and are shoveled into bucket conveyors having a capacity of 8 tons per hour, which carries them to a metal hopper outside of the boiler room. From this hopper they are emptied into wagons or trucks for proper disposal.

Water used for steam making, manufacturing and domestic purposes is obtained from the local water

mains, while that for the refrigeration system comes from a 1680-ft. well by means of an electrically-driven 160 gal.-per-minute Keystone deep-well pump, the working barrel of which extends to a depth of 185 ft.

In the Boiler Room

For the generation of steam, 3 boilers are installed, one of which is a Stirling water-tube unit rated at 230 hp. and equipped with Illinois traveling chain grates operated by an electric motor, and fitted with Vulcan soot blowers. The other 2 are 16 ft. by 7 ft. 6 in., Murray Iron Works marine type boilers, each rated at 180 boiler hp. and fitted with a 36-in. Morrison furnace and a 6 by 6 ft. McMillan Semi-automatic Dutch Oven. Pressure carried depends upon the load and varies from 125 to 150 lb. gage. Due to the higher efficiency found to be obtainable thereby, these boilers are ordinarily worked at from 45 to 50 per cent of their rated capacity, while the Stirling is made to carry about 125 to 130 per cent of rating.

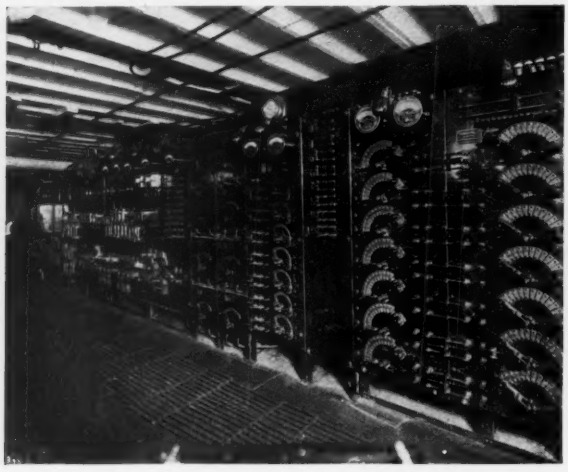


FIG. 2. MAIN SWITCHBOARD; CHARGING PANELS IN FOREGROUND

An interesting feature of the marine boilers is the soot blower employed. This was designed by the company's chief engineer, W. Ehrlich, and consists of a 2-in. steam line fitted with 4 sets of fork-shaped blowers having 5 jets each, and placed directly opposite the tube-openings. A swinging joint provides the proper steam connection and allows the fitting to which the blowers are attached to be rotated so as to direct the jets of steam through the desired row of tubes, an indicator adjacent to the control handle on the outside of the setting guiding the operator as to the row of tubes being blown. Steam for the various sets of blowers is controlled by individual valves operated from the outside.

Like many other power plants located within the confines of a large city, it is necessary that the boiler blowoffs discharge into the city sewers. To avoid the possibility of damage to property or danger to human life when such method is employed, the blowoff header is connected to the center of a 42-in. by 10-ft. tank placed vertically in the rear of the battery of marine boilers. The lowest point of this tank is connected to the sewer and the top by means of a short length of piping to the furnace chimney, so that as the boilers are blown down, the steam is allowed to escape through the stack which thus relieves the pressure and permits the water and sediment of discharge to gravitate to the sewer system with practically no pressure.

In the boiler room are also a Stillwell feed-water heater, a 66-in. by 16-ft. heater made out of an old return tubular boiler and utilized to heat the water used for domestic and manufacturing purposes, one single and 2 duplex boiler feed pumps of Deane and Blake & Knowles makes respectively, each equipped with Hills-McCanna force feed oil pumps, 2 Marsh vacuum pumps employed in connection with the heating system and a 12 by 8½ by 12 in. Fairbanks-Morse elevator pump equipped with a Fisher Governor Co.'s pump regulator.

No records are maintained or continuous tests made of boiler performances, but from readings obtained during tests recently conducted on one of the boilers by Fred J. Postel Co., Consulting Engineers of Chicago, an idea may be had as to the average stack temperature, CO_2 content of the flue gases and combined boiler and furnace efficiency, the good showing of which is claimed to be due to the use of the McMillan furnace. The results of these tests are shown herewith.

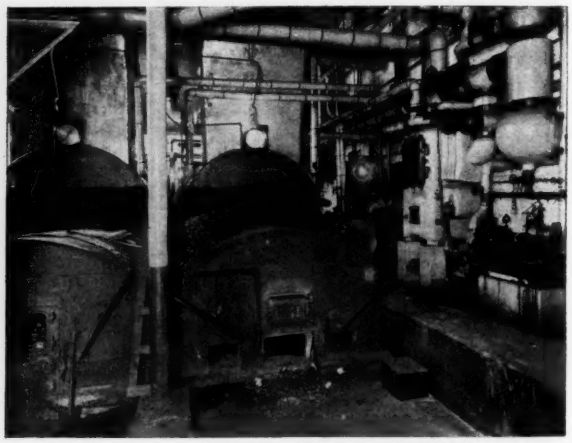


FIG. 3. CORNER OF BOILER ROOM SHOWING FEED-WATER HEATER AND PUMPS AND MARINE TYPE BOILERS FITTED WITH MCMILLAN DUTCH OVENS

The Engine Room

Adjacent to the boiler room but at a somewhat higher elevation is the combined engine and refrigerating machine room and machine shop, in the latter of which all power plant, bakery and electric vehicle repairs are made. The equipment of this shop consists of a 4-in. pipe cutting machine, a Hoefer No. 2 drill press, an 18-in. lathe, 24-in. stroke shaper, machine shop saw and emery wheel.

The greater part of this room is, however, occupied by the electric generating and refrigerating units. The former equipment consists of a 250-hp. cross-compound Fitchburg steam engine operating at a speed of 150 r.p.m. and direct connected to a 150-kw., 125-v. Crocker-Wheeler direct-current generator, a 125-hp. single Fitchburg steam engine operating at a speed of 200 r.p.m. and direct connected to a 75-kw., 125-v. Crocker

Wheeler direct-current generator and a 150-hp. single Murray steam engine belted to 2 Crocker-Wheeler direct-current generators rated at 45 and 65 kw. respectively, both with a normal e.m.f. of 125 v., thus making it possible for any of these units to be operated in parallel.

The Fitchburg units, the most recently installed, are fitted with special sheet-metal safety guards covering the crank cases, governors and flywheel, and each is provided with an individual oil pump belted from the crank shaft, so that as soon as any engine is placed in operation, the overhead supply filter and reservoir will be replenished and a continuous supply of oil insured for the units in operation.

One horizontal single-cylinder steam-driven Union Steam Pump Co.'s air compressor, and one 15-ton Hercules electrically driven refrigerating machine, now exclusively used as an air compressor, are employed

FIG. 4. GENERAL DATA, MARINE BOILER TEST

GENERAL DATA - BOILER TEST - CASE & MARTIN COMPANY, CHICAGO, ILL.

DATE, July 22-23, 1915. TEST BEGUN, 4:45 P. M. TEST ENDED, 12:45 A. M.

TYPE OF BOILER, Marine. SQUARE FEET HEATING SURFACE, 1340

TYPE OF STOKER, McMillan Dutch Oven. SQUARE FEET GRATE SURFACE, 6 by 6

	PRESSURES			TEMPERATURES				GAS ANLS.
Time	Steam Gage Lb.	Draft over Fire In.	Draft in Uptake	Feed Water Deg. F.	Steam in Cal'r. Deg.F.	Flue Gases Deg.F.	Air in Boiler Room Deg.F.	CO_2 Per Cent
PM								
4:45	115			220				
5:00	110							
5:15	115			224	252			
5:30	120			214	254			
5:45	120			222				
6.00	120			224	254			
6:15	125			224				
6:30	130			222				
6:45	140			222	264	535		11
7:00	135			222				
7:15	140			224		550		12
7:30	140			224	260	575		
7:45	140			224				
8:00	135	0.16	40	224		575		
8:15	130			222		565		12
8:30	130	0.15	40	224	252			
8:45	130			222				
9:00	130			222				
9:15	135	0.16	40	224	260	615		10
9:30	140			223				
9:45	135			222				
10:00	140	0.16	40	222	248	590		10
10:15	140			222				
10:30	135			222				
10:45	135	0.15	40	220				
11:00	137			222	246	590		10
11:15	137			220				
11:30	138			220				
11:45	138			220				9
AM								
12:00	132	0.15	45	222	242	620		8.5
12:15	130			222			100	9.5
12:30	130			222				
AVERAGES	131.3	0.152	40.9	221.9	253.2	580		10

Feed water thermometer reads 4 deg. high.

to furnish the necessary air at a pressure of approximately 100 lb. per square inch for cleaning purposes around the bakery and the operation of pneumatic tools such as calkers and riveters used in the machine and repair shops.

With the introduction of gasoline and electric automobiles have come added duties and the need of special knowledge on the part of present-day power-plant engineers. Evidence of this may be seen by the switchboard of this plant, which in addition to the regulation generator and feeder control panels has built integral with it an electric automobile charging board capable of charging the batteries of 29 delivery cars simultaneously. The capacities of these cars range from 1000 to 5000 lb.

While formerly batteries of the lead type had been used for the operation of the motors of these vehicles, the latest Edison batteries, the capacities of which are from 150 to 375 amp.hr. depending upon the size of the car, are now employed and due to the fact that these batteries may be charged at 120 v., they may be cut directly in circuit without the introduction of large resistances. The leads from the individual charging panels are carried in iron conduit to terminal boxes placed at convenient points in the car storage house, and fitted with the necessary charging plugs.

Refrigerating Equipment

Back of the switch and charging board, which is so placed as practically to divide the engine room into 2 departments, is placed the refrigerating equipment consisting of one 40-ton Carbondale absorption machine, one 20-ton White refrigerating machine, brine tank, centrifugal brine circulating pump and condenser coils, used in connection with 7 refrigerating rooms wherein are stored the butter, eggs, fresh fruits, milk, cream and other materials used in the baking process. Two of these rooms have dimensions of 20 by 18 by 7 ft.;

FIG. 5. RESULTS OF MARINE BOILER AND FURNACE TEST

BOILER AND FURNACE TEST

CASE AND MARTIN CO.

Date of Test	July 22-23, 1915
Boiler	Marine Type
Heating Surface of Boiler	1350 sq. ft.
Rating on Basis of 7.5 sq. ft. per Horsepower	180 Hp.
Furnace	McMillan Semi-Automatic
Duration of Test	8 Hr.
Water Pumped into Boiler	49,627 lb.
Feed Water Temperature	217.9 deg. F.
Steam Pressure	131.5 lb.
Calorimeter Temperature	283.2 deg. F.
Per Cent Moisture	2.89
Water Evaporated	48,193 lb.
Moisture in Steam	1,434 lb.
Factor of Evaporation	1.039
Equivalent Evaporation from Water at 212 deg. to Steam at Atmospheric Pressure, 1.039 x 48193 + (141.5 + 956.7) x 1434 =	50,282 lb.
Coal	6300 lb.
Equivalent Evaporation per Pound of Coal	7.98 lb.
B.t.u. per Pound of Coal as Fired	11,440
Efficiency = 7.98 x 965.7 + 11,440 =	67.3 per cent
Average Boiler Hp. developed during test	182.2
Load Per Cent Rating of Boiler	101.2 per cent.

one, 10 by 10 by 7 ft.; one, 10 by 16 by 7 ft.; one, 22 by 28 by 9 ft., and 2, 21 by 24 by 10 ft. The temperature maintained depends to a great extent upon the nature of the material in storage and varies from 14 to 46 deg. F.

Load and Operation

As much of the work in an industry of this nature is done at night, the lighting load is often equal to, or greater than, the power load, the approximate maximum of the former being 350 amp. and of the latter 300 amp. The maximum load ever carried at one time was 1800 amp., which at a voltage of 125 represents 225 kw.

The low cost at which the Case & Martin Co. is able to generate current may be attributed to a great extent to a good load factor due to the fact that the greatest amount of energy called for by the bakery is during the early evening hours; the charging load is carried after this until morning, and the remaining bakery motor load during the day proper, tending to produce a well balanced load curve.

Efficient Operation of Boiler Rooms

MUNICIPAL PUMPING PLANT EMPLOYS EXCELLENT OPERATING METHODS AND SECURES EXCEPTIONAL RESULTS FOR HAND-FIRED PLANT

IN the boiler room of this municipal pumping plant are 8 300-hp. Badenhausen water tube boilers. These boilers are suspended in a channel frame which is incased in a brick setting.

The baffling employed is a special arrangement worked out to give a uniform flow of the gases over the tubes, making allowance for the drop in temperature. This arrangement is shown in the accompanying sketch.

Normally these boilers are run at about 130 per cent of their rating, and with this load the efficiency is between 65 and 70 per cent, but at full load the efficiency varies between 76 and 80 per cent.

Dean grates with an air pressure of 20 per cent are used with these boilers, but the plant is experimenting with Grieve grates, having an air space of 10½ per

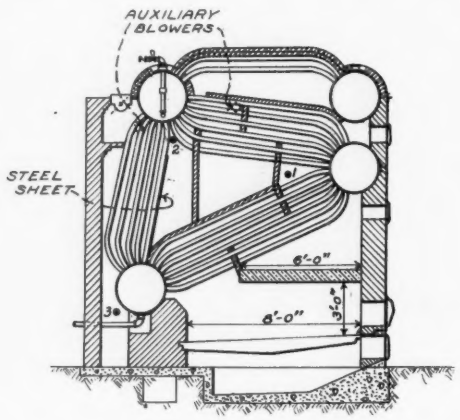


DIAGRAM SHOWING FURNACE PROPORTIONS, ARRANGEMENT OF BAFFLING, LOCATION OF AUXILIARY SOOT BLOWERS AND TEST DRAFT GAGES

cent and Coxe grates with 20 per cent air space. These are all dumping grates with herringbone bars. The coal used is anthracite No. 1 buckwheat, and the distance between the grates and the ignition arch is 3 ft., which is the same as the height of the tubes above the back of the grates. The dimensions of the grates are 9½ ft. wide by 8 ft. deep, making the ratio of heating surface to grate surface 40 to 1. There are 3 firing doors to each grate.

Water columns are placed at the front and to one side of the boiler setting, the connections being to the 2 front drums. These are equipped with high and low water alarm features, and while the boilers are in operation are blown down each watch, making 3 times a day. At the same time the gage cocks are tried to see that the water column is not stopped up. There are no fusible plugs in this boiler.

The feed line enters the upper back drum and the internal arrangement is a perforated pipe which extends the full length of the drum. Two blowoff pipes are connected to the lower back drum, in each of which is a gate valve and a blowoff valve.

Safety valves are provided in accordance with the local law, there being 2 to each boiler attached directly to the front steam drum by means of a riveted flange. These are tried out every shift to make sure the disc is not sticking to the seat. Non-return stop valves are placed in each lead from the boiler to the steam header.

Two boilers are placed in each setting, and for access to the interior of the boiler a manhole is placed in the exposed end of each boiler drum. There are no steam baffles nor dry pipes in this boiler, but the steam is slightly superheated as it leaves the steam drum. The pressure ordinarily carried is 150 lb. with the safety valve set to blow at 160 lb.

As previously stated, these boilers are hand fired with No. 1 anthracite buckwheat coal, which has a heat value of about 11,500 B.t.u. and analysis shows 50 per cent volatile matter, 2 per cent moisture, and about 20 per cent ash.

In firing, the coal is spread from the doors in rotation, not more than 2 boilers being fired at one time. After the fresh coal has started to ignite a light levelling bar is employed to spread the coal and cover up any holes which may have developed. The furnace is fired while the coal is incandescent, and before it breaks into holes. The average depth of the fuel bed is about 5½ in., and when it accumulates to 8 in. the grates are dumped. This is done by cleaning one section at a time, the live coal from the front being pushed to the back, and the front dumped, then the live coals drawn to the front and the back dumped, after which the coals are spread over the entire section and new green coal thrown on. The grates are not of the shaking type and the fire is never worked with a bar except in case clinkers are formed when it is necessary to remove them before cleaning time. By this process of cleaning it requires about 15 min. to each furnace, and cleaning is done every 3 to 4 hr. according to the load and quality of the coal. Firemen are instructed to close the dampers somewhat when cleaning the fires. Only 6 to 7 shovelfuls are thrown on each section at a time, and this is spread lightly over the entire surface, and makes the firing periods at short intervals. Under ordinary operation about 21 lb. of coal are burned per sq. ft. of grate surface an hour, and the equivalent evaporation from and at 212 deg. is about 8 lb. of steam per pound of dry coal. Coal is purchased on the B.t.u. basis with a penalty for a deficiency.

Forced draft is employed under the grates, the pressure of which is automatically regulated according to the steam pressure. Under ordinary operation the pressure under the grates is 0.6 in. of water; over the grates the draft is 0.1 in., making a drop of 0.7 in. through the fuel; on the boiler side of the damper the draft is 0.3 to 0.4 in., and in the flue the natural draft is 1.3 in.

As an aid to the fireman 2 draft gages are attached to each boiler setting, one showing the amount of pressure under the grate, the other the draft in the furnace.

Coal is weighed as it is delivered to the bunkers in wagons, and as firing is done from industrial cars the number of cars of coal used are counted each shift. At the time of our visit the feed water was not measured, but provision was being made to have a continuous record of the amount of water fed to the boilers. There are no steam meters in the plant. The temperature readings taken for the record are the condensate returning to the feed water from the condenser which averages about 110 deg., and the water from the heater to the boiler which is about 170 deg. There is no economizer in the plant.

For heating the feed water a closed heater is employed and an open heater is being installed. These will take the exhaust from the auxiliary units about the plant.

Frequent tests are made to see that the furnace and boiler are in the best operating conditions, and during these tests, which are run under normal conditions, the following average temperatures through the setting have been found: In the furnace, 1857 deg., at the end of the first pass 876 deg., end of second pass 608 deg., at the end of the third pass 518 deg. Gas analyses are made during the test periods only, when continuous samples are gathered and an analysis made of the mixture which has collected during the entire 24 hr. The average CO_2 which is obtained in the gases is 12 per cent. It is stated that at times samples have been taken which have as high as 20 per cent CO_2 in the gases.

River water is used for feeding the boilers and the quality varies greatly. To overcome this difficulty a Rice system of water softening has been installed. At the time of our visit the boilers had been in operation for one year, but it had not been found necessary to give them an internal cleaning. To keep the boilers clean of soot, steam blowers have been installed in places not accessible to the hand blower, and these are operated every time the fires are cleaned. Hand blowers are used once each day. When using the steam blowers, which are located as shown in the sketch, steam is turned on for about 30 seconds. By this means of blowing the soot it has not been found necessary to shut the boiler down for an external cleaning.

The ashpits are in the form of a hopper and made of metal lined with concrete. These discharge into industrial cars which run on tracks underneath the boilers. These cars discharge into the hopper of the conveying system which elevates the ashes to a storage from which they discharge to auto trucks.

Coal is brought to the plant in wagons and is discharged to a bunker with its floor on a level with the boiler room basement. From the bunker the coal is loaded into industrial cars and elevated to the boiler room floor where the cars are run on tracks and pushed in convenient position for the firemen to use when firing the furnaces.

The settings are gone over frequently with a candle or torch to discover whether any air leaks exist.

Ice and the Water Wheels

WHAT THE CHIEF TOLD THE OILER ABOUT ANCHOR ICE AND THE GATE GEARING. BY G. H. KIMBALL

"SAY Mr. Wallace," said Richards, the apprentice oiler, to the watch engineer; "I see by this magazine that there are a lot of big plants in the country run by water; that so?"

"It certainly is," replied Wallace, "and they're building more of them all the time."

Richards studied over the magazine a while, and then broke out with: "It says here that there are single wheels that will develop as much power as all of our engines put together."

"Yes; there are a good many with as large wheels as that"; said the engineer. "It often seems to us working in the city where steam is the only power to generate electricity, and where even the feed water must be drawn from the city supply, that there is no other primary source of power.

"But water was used first and later steam came to help out. Of late years, however, engineers have been urging the value of water power, and immense areas have been flooded to supply power stations that cost much more than a steam station of the same capacity would."

"That's funny. I never knew it," said Richards; and then: "Did you ever work one of those plants?"

"Yes, I had charge of one of 800 hp.

"Tell us about it."

"To begin with," began Wallace, "I had been working at the engineering business about 3 yr. when I had a chance to take charge of a lighting and power station in my home town of Glendale.

"The company had been in business about a year and were having the hardest kind of a time to make things go. Money enough had been spent on that power plant to make one of the best of its size in the country but it had been largely thrown away and they had a building that was low and unsuited to steam machinery.

"They had expected to have plenty of water to run with and had installed 2 wheels of 400 hp. each, and instead of belting each one to a separate generator or a separate part of the jack shaft, they had made the shaft in one piece with only 2 solid couplings in it so that there was no way to disconnect any one part in a short time if it gave trouble.

"Besides the water power, there were 3 steam engines, 2 boilers and some other equipment. Then there were 2 railway generators and 2 alternating-current machines for the lighting and power load driven from the shaft."

"That was quite a plant for a country town," commented Richards.

"It sure was, and also it was quite a proposition for me to undertake to handle at that time"; was the reply. "It is strange how any one will absorb knowledge if he has to and for a time experiences came pretty fast."

"Wouldn't it have been better to connect the water wheels directly to the generators?" asked the oiler.

"Very much better," said Wallace, "and that was one of the mistakes made in designing the plant. The wheels were of the horizontal type containing one runner (some have 2), and were set about 50 ft. below the jack shaft which made a belt necessary. The general layout of the drive from the wheels was like this,"—making the sketch, Fig. 1. "You see the station was on a side hill which was the bank of the river so that the wheels were much lower than the generator floor. The belts from the wheels ran to pulleys in the center part of the shaft, and the engine shown was on the end farthest from where you are looking. There was also another engine which I haven't sketched that was direct-

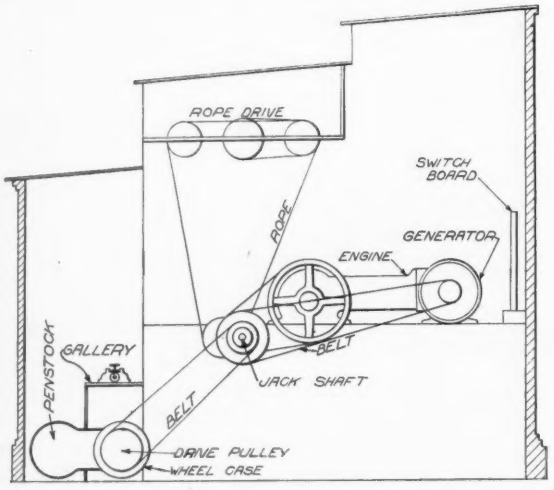


FIG. 1. ELEVATION OF WATER WHEEL AND ENGINE DRIVE

connected to the end of the shaft nearest us. Above the penstock was a gallery where the first regulator for the wheels was placed, with stairs leading down from the top floor around the shaft to this regulator, and when the flow down the river varied much, we had to run down there many times in the course of a day. It was a bad idea, too, to put the regulator in the wheel house, for it was as cold as out-of-doors there and the water that was used to operate it would freeze.

"Belts from the wheels were 48 in. wide, and one to each railway machine was 20 in. wide and they ran in such a way that there was little trouble with them. These with the alternating-current machines made quite a little machinery driven by the shaft.

"Was there any machinery driven independently of the jack shaft?" asked Richards.

"Only one; a 75-kw. alternator; and that was one of the weak points of the plant, which made it very important that the shaft should not stop. I used to keep close watch on the bearings, but often the pins in the clutches would come loose so that they could not be thrown in and we would have to stop; but this never happened in the time of heavy load, so that we did not affect the service because of it.

"The first winter that I was there the wheels didn't do much, as there was little water coming down the river."

"How was that?" asked Richards.

"Well, the weather was so cold that most of the water was frozen up. In a deep slow-moving river a low temperature wouldn't have had so much effect, but in one like that there were many rapids and the water was exposed to the air much of the time, so that it cooled down and would freeze easily, so there was not much flowing.

"The second winter we were better prepared in some ways, but the troubles were all different from those of the first year. It was not a question of carrying the load by steam so much as by water, for there was more flowing down than before. It was what is called an open winter, with the weather warm enough to keep the ice from forming most of the time. Water was good for turning the wheels, but there were certain drawbacks."

"What were they?" asked the oiler.

"You see that river ran over rocks, and there were times when from a sudden drop in temperature the rocks would be cold enough to freeze the water partly as it ran over them, so that the water came down in the form of slush, called anchor ice.

"That was my first experience with it, and I didn't know how to handle it; and one of the first days that it began to run, our gates were opening and closing on account of the variable load. If the load had called for a steady opening most of the slush would have run through; but every time the gates partly closed, it would be held in the wheel case and would pile up over the gates throwing a heavy load on all of the gate machinery, breaking the gears as well as some other parts."

Here the engineer made a sketch, Fig. 2, and explained:

"I have marked here the names of the principal parts and you can see where the gate shaft comes out of the wheel case through the stuffing-box. On the end of it was the large bevel gear *X*, and the smaller one *Y* meshed into it at right angles. The shaft *C* was driven from the regulator by a wire rope wound around the sheave wheel. The bearing *B* was on the wall and the bearing *A* was held by a cast-iron post set in a bracket bolted to the end of the wheel case. The load became so heavy on the gates that the gears *X* and *Y* partly stripped and the side pressure also broke the post holding bearing *A*, which allowed the shaft to swing over near the drive pulley. The manager ordered some new parts and this wheel had to be cut out until they were in place."

"Why is the temperature of the water different in different winters?" asked Richards.

"Well, in an open winter," said Wallace, "the river is not covered over so much and the water comes nearer

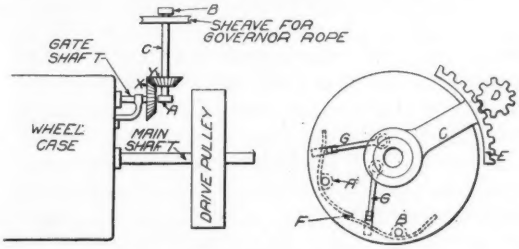
the temperature of the air. In a winter where there is a thick blanket of ice over all the smooth parts of the river, the water is warmer than the outside air, and the rocks can't cause anchor ice to form.

"We had another experience with ice forming on the metal bars of the rack. There apparently was none floating in the water, but it would soon plug up the spaces unless we kept raking it out. This didn't occur often, for the temperature was not very low and as soon as the air warmed up some in the morning, it stopped; but it is hard to understand how the rack bars that were in 20 ft. of water could be enough colder than the water to cause ice to form on them."

"It seems there isn't any kind of power that doesn't give some trouble," said the oiler. "I suppose a water-power plant was free from trouble and different from a steam plant."

"In most cases, the water plant is easier to operate," said the engineer, "but when anything happens to the wheels it is sometimes hard to make the repairs."

"Here, this sketch Fig. 3 shows the arrangement of the inside gate gearing. I have drawn only 2 of the gates but that shows the principle as well as more. This large circle represents the plate next to the runner; the smallest circle the shaft. The casting *C* turns on a bushing built over the shaft. You see the rack *E* on the end, and the gear *D* is on the end of the shaft that projects outside of the casing as shown in Fig. 2 with the bevel gear *X* on it.



F16.2

F16.3

FIG. 2. PARTS OF THE GATE MECHANISM
FIG. 3. GATE GEARING INSIDE THE WHEEL CASE

A and *B* are gates, and these are placed all around the large casting turning on the studs at *A* and *B*. The arrow *F* shows where the gates will open, and the rods *G* are connected to them and also to the circular part of the casting *C* on pins similar in their action to a crankpin so that the movement of *C* by the gear *D* causes the gates to open or close. The gates are shown as being behind the large plate and you can see that the stud that they turn on is not in the center so that they are not exactly balanced and the pressure of the water tends to close them.

"One day later in the same winter that the other accidents occurred, we had a quick freeze and it is probable that this gate gearing became badly stuck up with ice, for we found that after a time we couldn't close one of the wheels tight or open it wide; so there was nothing to do but get inside of the casing and find out what the matter was. It was a day in February and there was a lot of ice in the river, and the water was some cold. In most water-power plants there are gates in the penstock leading to each wheel so that, if one of them is to be repaired, the water can be shut off from the wheel alone and the others used. In this plant there was no such luck, and the whole canal had to be drawn off by closing the head gates which were about 100 yd. up the river and then letting the water out through the wheels and a 36-in. waste gate at the bottom of the dam.

"The water was out of the canal at 8:30 in the morning, but the head gates had ice on them and wouldn't close tight, so the manager got the line gang working to push down bagging with boards to stop the leaks. Then a stump wedged in the waste gate which partly stopped that up until it was finally pulled out with chain falls. So it was 4 p. m. before the water was all out of the wheel case so that we could work in it.

"We found there were 7 of the bars marked *G*, Fig. 3, that were bent so that the gates connected to the bent bars would close first, while the ones with undamaged bars would stay open, and would open wide first.

"The work of replacing these damaged bars took until nearly midnight, and we were a tired crowd when we went to open the head gates."

"That was sure some job," said the oiler.

THE FINEST and most accurate maps of the United States are those made by the United States Geological Survey. This branch of the Government service prints more than 3000 maps a day, or about a million a year, most of which are sold to the public directly from Washington. Book and stationery concerns in the larger cities of course handle these maps, but heretofore there has been no way in which the inhabitants of the small towns throughout the country could get them except by sending to Washington. Now, however, postmasters in towns and villages have the permission of the Post Office Department to handle these maps. When the Geological Survey prints a new map it sends a sample copy to the postmasters in the area covered, with the suggestion that they tack it up in a conspicuous place, where everyone calling for mail can see it, and order a small stock for sale to those who wish to buy the map. This saves the purchaser the annoyance of sending to the Geological Survey and waiting until the map is received from Washington and also saves the expense of postage. The postmaster himself receives a small commission on each map sold.

Many active postmasters are handling the maps, and that their fellow-citizens appreciate the accommodation of being able to buy Government maps at the postoffice is shown by the number sold in this way. The record of maps so sold shows that a postmaster in Minnesota heads the list so far, having sold 125 maps the first month he handled them.

Only postmasters in regions that have been recently mapped have been asked to handle the maps, but the Geological Survey willingly answers inquiries made by other postmasters, sending them a sample copy of the map that covers their district, if it has been mapped.

It is believed that this new plan of distributing the Government maps will benefit all concerned.

Boiler Feed Water---VII

THE ECONOMIC VALUE OF WATER SOFTENERS. BY F. F. VATER

THE cure for troubles caused by incrusting matter in a boiler feed water is in the use of a good water softening plant.

There are conditions, however, where this investment is not justified. A device of the kind should pay for itself in savings in, at the most, from 5 to 6 yr. In other words, a softening plant should pay a dividend of about 20 per cent on its cost each year.

In many cases, a good softener will pay out the investment in 1 yr. or 18 months. Again the dividends on its cost, will be 33⅓ per cent, paying out in 3 yr. If conditions are such that more than 6 yr. are required for the savings to equal the cost of installation, it is questionable if the investment should be made. A dividend of 20 per cent is earned only after a charge is made against the machine of 10 per cent for interest and depreciation. That means, if a softener costs $1800, the annual charge for interest and depreciation will be $180. To this, should be added the cost of chemicals and labor required in its operation.

The machine should be credited with the savings in coal it will make; the savings in labor required in cleaning boiler; the savings in compound bills; the savings in depreciation in boiler settings; the savings in repairs to the boiler including cost of replacing tubes; damage to sheets and all maintenance cost eliminated by its use. It should be credited also, with interest on the investment at 6 per cent per annum for the greater number of hours it is kept at work, due to less frequent cleanings, and it should be credited with the increased plant output, whatever this product may be, due to its ability to keep boilers at work a greater number of hours. The maintenance costs should be figured from an average of at least 5 yr; 10 yr. is better yet. You might get through 1 yr. or 18 months without much of any expense and the next month or two have some large bills to pay.

Figured on this basis, the machine is getting a square deal and you are not deceiving yourself as to the benefit you obtain by its use. Each one of you, with a little care, can ascertain accurately just what the use of bad feed water is costing you in the various items named above to be credited to the machine, with the possible exception of the coal saving, and a safe method is given you below to estimate this.

Ten pounds of coal per hp. will be consumed in cooling a boiler down, heating it up, steaming to the pressure carried ready to cut into the steam line.

The maximum saving in coal due to clean heating surfaces should not be estimated above 5 per cent, and from that down to 1½ per cent in any well operated plant.

In making up an estimate of the saving that can be made by an investment in any plant, it is always good policy to make your estimate conservative so that the result you actually show after an installation is made, will be fully equal to or better than your estimate. I think there are many cases with engineers, where improvements are asked for that they are turned down by the management simply because the matter is not presented in a comprehensive way.

The average business man knows little about his steam plant. He is not well informed, and with this class, a clear conservative statement from the engineer of the dividends that can be expected from a further investment will be appreciated, and if properly presented will obtain the appropriation, while a loose, somewhat wild statement will not get the owner's confidence, and you will be turned down.

The business man is fully capable of figuring interest and dividends, and if his business is profitable, there are few of them to whom 20 or 30 per cent on an investment won't look mighty good. Again I say, be sure to keep your estimate conservative, so that you can "make good" in the show down.

There are a number of water softeners on the market, all with more or less merit. Any one of them, well cared for, will help. Some are better than others. It will pay you to buy that machine which will deliver the best results on the least labor and chemical cost.

If it is desirable to remove incrusting matter from feed water, the more that can be taken out, the greater the savings will be. The only possible danger in getting a water too soft, lies in the use of too large an excess of soda ash. It is not always safe to take a salesman's word for the labor cost. Investigate for yourself. Representations have been made that labor costs are 3 hr. a day, while in actual use, operated by yourself, it will require 10 hr. attention, if you obtain a good result.

There are other systems where the labor required will be 24 out of 24 hr., if good work is obtained.

On the other hand, there are systems where the labor required will not be more than 3 hr. in 24 hr.

There is quite a difference also in the cost of chemical required by different systems, and this must be taken into consideration. The first cost of a system is a secondary matter.

Some methods require the use of an excess of soda ash above the theoretical requirement, which adds materially to the chemical cost of operation.

There seems to be a point where the chemical ceases to act on the impurity without using it in excess. In times past, this point of minimum solubility of the lime and magnesia was placed at 5 grains per gallon, which means that you could not reduce the hardness below 5 grains by chemical treatment.

This opinion, however, is wrong and no doubt, arose from the fact that many makes of softeners offered in the market cannot reduce the incrustants to 5 grains, without using an excess of soda ash. In fact, no system, treating water cold, that is, at temperatures ranging from 100 deg. F. down to 40 deg. F., can obtain a hardness remaining in the treated water, of 5 grains per gallon without excess soda ash.

In a plant exceptionally well cared for, a machine was installed to handle 12,000 gal. of water an hour. It was what is known as a cold process, and was built without filters. The average results obtained extending over a period of 5 months, follows:

Average hardness remaining in the water after treatment, 4 grains per gallon; average excess of soda ash fed, 5.52 grains per gallon. Due to the lack of efficient filters, a coagulant was fed to keep the precipitate thrown down by the chemical outside of the boilers.

This is a much better result than is usually obtained from this make of softener, and as a matter of interest, we will compare the cost of operation, as given above, with the operation cost of better methods.

In a properly designed softener, it is never desirable to feed a coagulant. Proper filtration will remove the precipitate from the treated water, without any chemical cost whatever.

This cost of coagulant is 75c per day for 12,000 gal. of water an hour, and as the plant was constantly in operation, 365 days in a year, the annual cost of coagulant was $273.75. In other words, the purchasers of this machine would have received a dividend of 20 per cent per annum on an investment of $1350, more than they paid by installing proper filters at the time the installation was made.

Softeners can be bought which would have reduced the incrusting matter in this water to 2 grains per gallon, instead of 4 and with the use of 1 grain excess soda ash, instead of 5½ grains excess. This saving of 4½ grains of soda ash a gallon, based on soda ash costing 1¼c a pound, and on a water consumption of 12,000 gal. an hour, 24 hr. a day, 365 days a year, would have amounted to $843.15.

Then there is a question of labor cost. This was one of those cases where the labor required was not supposed to be more than 3 hr. a day. When placed in actual daily service, the time required was 10 hr. a day.

Other methods could have been purchased where the lime required to operate would not have exceeded 3 hr. a day, a loss of 7 hr. a day, 365 days a year, 20c an hour, would in a year amount to $511.

The total loss, therefore, is:

Coagulant	$ 273.75
Excess Chemical	843.15
Excess Labor	511.00
	$1,627.90

meaning that they spent annually $1627.90 more in operating the machine than would have been spent had $1000 more money been invested in the better machine in the first place. This mistake resulted in their receiving no dividends on their investment in a softener, while if the better machine had been installed, the dividends would have amounted to between 20 and 25 per cent.

To some men, this would be looked upon as a criticism of water softening. It is not, however; it is purely and simply a case of bad judgment upon the part of the purchaser. An efficient machine, costing more money would have paid well.

You may sometime be so placed that you will have to pass on the question of what water softener will be installed, and I will tell you how simple it is to decide and how you can make no mistake in such a purchase.

A water softening machine is not capable of carrying overloads without reducing materially the efficiency, and this is because chemical reactions require time. With a boiler or an engine rated at 200 hp., you can work 300 out of it; but not so with a softener, because when you buy a 200-hp. softener, and get 300 out of it, the time given the water passing through the machine is not sufficient for complete chemical reaction, and the work is but partially done.

Don't buy a softener on boiler horsepower rating. Buy it on its capacity in gallons per hour. If your boiler plant is 500 hp., nominally rated, you may be taking 750 hp. out of it, and for good results or dividend results, the softener would have to be 750 hp., or 3000 gal. of water an hour.

Know, therefore, how many gallons of water you will evaporate and get a machine large enough to take care of that quantity. Do not buy any softening system that does not include down flow sand filters. There is no use in treating a water in a softener and then permitting precipitated sediment to pass through your feed lines into the boilers. You will be sure to have stopped up feed pipes, and you will have sludge in your boiler which increases the density of the water you are evaporating, causing an increased coal consumption.

Take a concrete example. Plant 1000 hp. with poor filtration, 3 or 4 grains per gallon of sludge will go into the boiler. Say 4 grains, and you are evaporating 4000 gal. an hour. In 1 hour's time, you have put into your boiler, 4000 grains of sludge; in 24 hr., you have put into your boiler, 96,000 grains of sludge equal to 13.7 lb. Keep this up for 30 days and you have put into your boiler 511 lb. of sludge, which should not be there. This would bring your density way up. Four grains per hour, 24 hr. a day, 30 days, your water in the boiler would contain 2880 grains of sludge per gallon, equal to a density of 1.049, which is much worse than sea water.

In fact, you could not run 30 days under such conditions. Long before the 30 days were up, your boilers would shut you down, foaming unless you blew down frequently, which costs money.

Inasmuch as a filter will keep this sludge out and further imposes practically no maintenance cost if it is a down flow sand filter, install it as a part of the softening plant. There is but one other point you need to consider. Exact from the manufacturer a guarantee that the hardness of the treated water shall not exceed 2½ grains per gallon, and that the causticity of the treated water as shown by a phenal test, shall not exceed one.

Now why exact that the hardness be as low as 2½ grains per gallon? Because the difference between a hardness of 2½ grains and 5 grains per gallon is the difference between having no use for a turbine for the boiler tubes and having to have one kept in good repair.

Exact the guarantee on causticity, because that controls the quantity of soda ash he can use in excess to obtain the results, and hence, governs the chemical cost of treatment. This is vital. If you exact a guarantee of zero hardness without exacting the limit of caus-

ticity, he can meet the guarantee on a test run, but foaming would shut you down in a few hours and the cost of softening would be so high as to eat seriously into your dividends, or eliminate them altogether. This information is not only absolutely reliable, but it is new. It is not in print. It is inside information.

If a manufacturer will not bid upon such a requirement, it is a prima facie evidence, he is not building the machine that will pay you 20 per cent or more dividends, and unless this can be obtained, you are hardly justified in making the investment.

A water softener is a good thing to better the conditions in your plant caused by incrusting solids, and suspended matter in your feed water, but it has no beneficial effect on the nonincrusting solids in solution.

If you have a brownish white deposit, wherever a leak occurs around your boilers and your pipe lines forming in some cases stalactites similar to icicles, a softener will not help you. These deposits are caused by the nonincrusting solids in your water. Break one

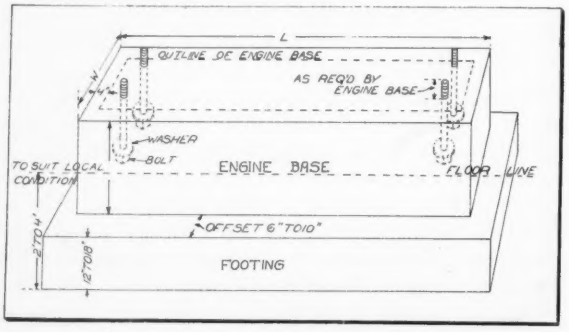


FIG. 1. DETAILS OF FOOTING AND FOUNDATION

off, put it to the tongue, it will have a salty bitter taste. It is soda or potash. A water softener will not remove it.

The next addition to your chart will tell you distillation is the cure, and that blowing down, if it is present in small quantity, will help. Blowing down helps only in that it reduces the density of the water, and hence, the liability to foam; but it does not affect the quantity present in the water, nor will it prevent these deposits. These deposits form because a drop of water will (through the leak) become exposed to the air. The water evaporates, leaving the soda as a solid.

There is no cure but distilling the water.

(To be Continued.)

Foundations for Small Engines.

FOR rigidity, durability and economy in constructing a firm foundation, Portland cement concrete is the best material, using steel reinforcing rods when needed at angles or in footings.

Usual proportions are, by volume, 1 part cement, 3 parts clean sand, screened through ¼ in. mesh, 5 parts crushed stone or gravel to pass a screen of 1½ in. mesh. For any part where reinforcement is used, a proportion of 1:2:4 should be chosen. In mixing the concrete, water should be sprinkled or flowed on to form a plastic mass, but not enough water used so that it will separate from the concrete on standing.

Locate the exact position of the center line of the engine and dig a pit the exact width and length of the required footing and of depth to take footing and foundation; the bottom should usually be 3 to 4 ft. below the floor level. Fill into this pit the concrete to the depth required for the footing, usually 12 to 18 in., bedding

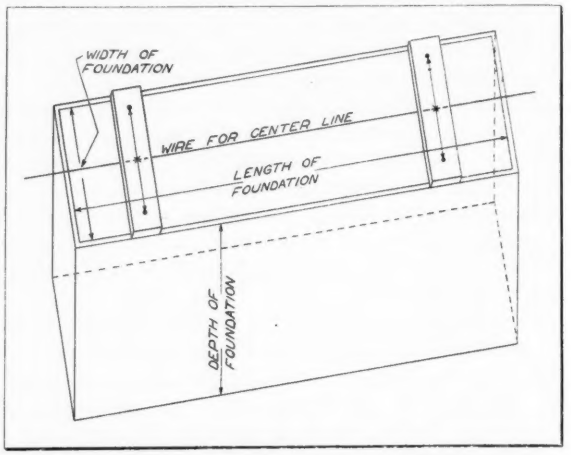


FIG. 2. FORM BOX FOR FOUNDATION WITH TEMPLATE FOR BOLT LOCATION ON TOP

some rough stones, 3 to 4 in. through half their depth in the top under the engine to form a key between footing and foundation.

For the form for the foundation, a box is constructed, 8 in. longer and wider than the engine base, and of depth to bring the engine at the desired height above the floor line. The inside should be well oiled to prevent the concrete from sticking.

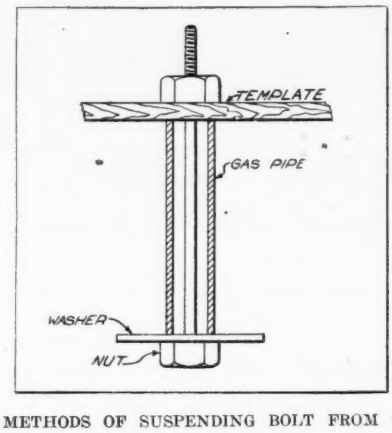


FIG. 3. METHODS OF SUSPENDING BOLT FROM TEMPLATE STRIPS

On top a template is placed to hold the anchor bolts, the location of bolt holes in the template being laid out after it is fastened to the top of the form box, all measurements being taken from the center line.

Place the box in position on the footing and suspend the bolts from the template, enclosing each bolt in a gas-pipe, twice the bolt diameter and well greased on the outside. Length of bolts and size should be chosen in accordance with the recent article by Terrell Croft.

After bolts are hung in place, test the location of the center line of the template to make sure that is as wanted for the engine.

Now fill the concrete into the form, twisting the gas pipes occasionally to make sure that they do not stick to the concrete, and tamping the concrete well with the end of the spade, especially along the sides of the form, to take out air bubbles and pockets.

When the form is filled, cover with damp burlap for 24 hr.: then remove the form and patch any holes with cement mortar made 1 part cement to 1 part sand. Also surface the sides of the foundation with this mortar if desired for the sake of looks.

After 48 hr., the engine may be placed in position, leveled, the bolts drawn up and the space around them filled with mortar. Load should not be put on the engine until the concrete has set for 10 days, as earlier use will be likely to produce cracks.

Historical Steam Engine

IN A recent letter to "Engineering" of London, Andrew Hamilton describes an interesting old Newcomen engine. The photographs shown were taken in 1905 at the Farme Colliery, Rutherglen, and show this old Newcomen engine and discarded "Bee-hive" boiler.

This engine is one of the most remarkable old steam engines in existence, its construction being very clearly shown in the photographs. The parallel motion is of an unusual type, and is not mathematically exact in its action, but sufficiently so for the required purpose. The valve gear is very simple and is worked by hand, just as was the case with the original Newcomen engine before Humphrey Potter invented the scroggan or Beighton the plug-frame.

VIEWS SHOWING NEWCOMEN ENGINE AT FARME COLLIERY, RUTHERGLEN

The engine draws a cage up in 16 revolutions and 35 sec., the piston traversing 192 ft. in the same time.

Diameter of cylinder	2 ft. 8¼ in.
Stroke	5 ft. 6 in.
Revolutions	27
Mean Pressure	7.35 lb.
Indicated horsepower maximum	27
Boiler Pressure	3 lb.

Scrubbing Brushes by the Mile

By H. K. Scholefeld

OUR 6-ton industrial locomotives often come in for inspection and repairs. To get the rough grease knocked off the eccentrics, brake rods, and under parts of the frame, we have a pretty good scheme.

A side track about 400 ft. long has been unused for several years, and on this there has sprung up a dense growth of woody stalked weeds, about 3 ft. high. This variety of weeds happens to be quite elastic, although not easily bent over, so that when disturbed it quickly recovers.

When we run our engine slowly back and forth over this natural toothbrush, the stalks slap around among the rods, etc., like long withes. Wind and rain soon clean up and restore the damaged brush, and new weeds are always growing. Thus, while conserving natural resources in the form of weeds, we also conserve some unnatural resources, such as overalls.

In comment on the present status of the Chamber of Commerce of the United States, President John H. Fahey gives the following facts:

Three years ago, the Chamber of Commerce of the United States was first organized. It had no membership, and no money in the treasury. Today it represents 680 commercial organizations, and nearly 300,000 business men, firms and corporations throughout the country. During the 3 yr., it has become a great constructive force in the life of the nation, helping commercial legislation, suggesting important amendments to the Federal Reserve Act, assisting in the readjustment of the Department of Commerce, and influencing modifications in the Trust Bills.

The Fourth Annual Meeting of the Chamber will be held in Washington, Feb. 8 to 10, and the Chamber stands committed, through referenda, to advocating the upbuilding of a Merchant Marine, a National Budget, and a permanent non-partisan Tariff Commission.

The Chamber of Commerce of the United States is a national business organization, acting as the voice of American business and speaking for all, not for any one interest or group.

Electrical Machinery and Appliances

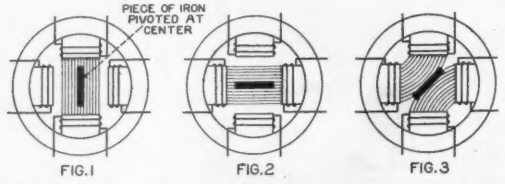
For Generating, Transmitting and Using Current

Induction Motors

General Construction; Windings; Theory; Details

IN THE most common types of induction motors, the rotor winding consists of a single copper bar laid in each slot with both ends attached to a short-circuiting ring at each end of the rotor. The rotor winding has no electrical connection with any outside circuit, but when polyphase current is impressed upon the stator windings a rotating magnetic field is set up which induces currents in the closed winding of the secondary or rotor. Reaction between the 2 windings causes the latter to rotate. In many respects an induction motor resembles a static transformer, the stationary part or stator of the former corresponding to the primary of the transformer and the rotor to the secondary of the transformer.

To illustrate more fully the action of an induction motor, a few comparisons will be made. It is well known that if a magnetic needle, free to rotate, be placed in the plane of a magnetic field, it will assume a position parallel to the line of force of the field. Now assume a



FIGS. 1, 2 AND 3. PIVOTED IRON BAR REVOLVES WITH SHIFTING MAGNETIC FIELD

4-pole magnetic field with 2 opposite poles magnetized by a current flowing in its windings as shown in Fig. 1. The needle is replaced by a small iron bar, free to revolve, which will also assume a position parallel to the lines of force. Now, if the magnetism is shifted to the second pair of poles, the iron bar will change to the position shown in Fig. 2. By exciting 2 pairs of poles at one time as shown in Fig. 3, the iron bar will assume a position diagonally between the 2 sets of poles. It can be seen that if one of these currents is increasing in value while the other is decreasing, the piece of iron will be attracted toward the former until it reaches maximum value, when if the currents are alternating, the one having reached its maximum begins to decrease and the other current having reversed its direction but having begun to decrease, attracts the piece of iron away from the first pole and in the same direction of rotation. If the action be continually repeated, the piece of iron will revolve, and its direction of rotation will be determined by the phase relation of the 2 currents, which may be reversed by reversing the leads of one phase.

If the piece of iron be replaced by an iron core wound with copper conductors, forming closed coils, secondary

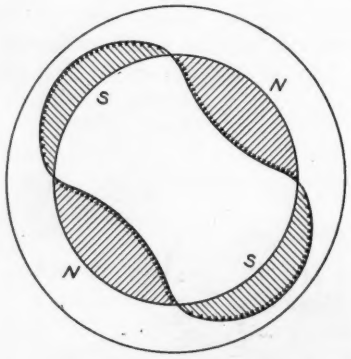


FIG. 4. DISTRIBUTION OF MAGNETIC FLUX IN A 4-POLE INDUCTION MOTOR

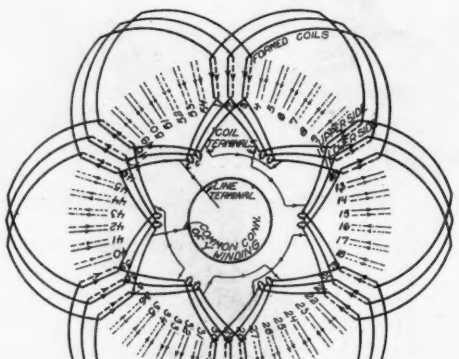


FIG. 5. STATOR WINDING OF 3-PHASE, 6-POLE INDUCTION MOTOR

currents will be produced in them which will react with the primary flux producing rotation as already explained.

Figure 4 will illustrate how the magnetic flux is distributed around the face of an induction motor field. The inner circle represents the face of the stator core

unbroken by slots. This machine is assumed to have 4 poles which will continually shift around the ring. The instant the centers of the poles are at the points N and S the magnetic density is the greatest at such points as represented by the arrows. The field instantly diminishes as a position either side of the center is reached until it becomes zero midway between the poles and begins to increase again in the opposite direction.

Since the frequency of the stator remains constant, the number of revolutions per minute of the rotating field is also constant and at no load the rotor revolves at nearly the same speed as the rotating field; the synchronous speed of the rotating magnetic field being determined by the frequency and the number of poles. At full load, the speed of the rotor of an induction motor is somewhat less than at no load. This difference in speed commonly called slip, is due to the fact that at full load, larger currents must exist in the rotor, thus requiring a greater generated secondary electromotive force, which in turn depends upon the relative speed of the magnetic field and the rotor. If the 2 rotated at exactly the same speed there would be no secondary current and the rotor would exert no torque. Slip varies

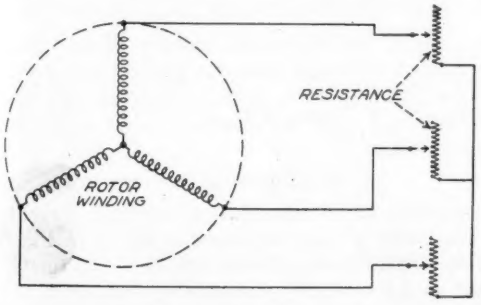


FIG. 6. DIAGRAM OF CONNECTIONS EMPLOYED TO VARY RESISTANCE OF ROTOR WINDING

from 1 per cent in motors designed for close regulation to 40 per cent in those badly designed, or designed for some specific purpose.

The stator winding of a 3-phase 6-pole induction motor is shown in Fig. 5 with one phase complete. The groups of conductors for the other 2 phases are shown by light and dotted lines, the connections between them being made in the same way as those for the phase drawn in. Each of the heavy outlined figures represents a stator coil. The constant speed induction motor is adapted to constant speed work of all classes and its inherent characteristics resemble those of a direct-current shunt-wound motor. The squirrel-cage type of induction motor, that is, one with a bar-wound closed-circuit secondary, is generally started by throwing in the main switch in sizes up to 5 hp. Above this size the usual method of starting is with a starting compensator consisting of an auto-transformer, and a multi-contact oil switch.

A modification of the squirrel-cage induction motor is used for many purposes. The stator is constructed like a constant speed machine, but the secondary or rotor is provided with a polar winding similar to that of the revolving armature of an alternator with a 3-phase winding. An internal or external resistance is connected in circuit with the rotor windings which may be cut out at will to vary the speed or may be used for starting only. This arrangement, shown diagrammatically in Fig. 6, is to vary the speed or to increase the torque at starting. This type of motor is especially valuable where voltage regulation is important. The maximum torque is independent of the rotor resistance and thus the speed at maximum torque depends upon the rotor resistance. Current at maximum torque is

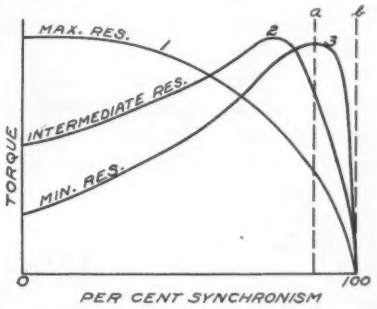
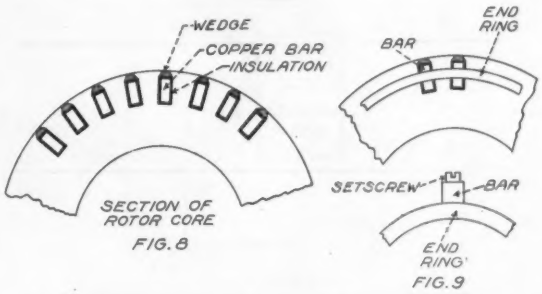


FIG. 7. TORQUE CURVES FOR POLYPHASE INDUCTION MOTOR

also independent of rotor resistance. The maximum torque occurs at a lower speed than the maximum output and a resistance can be chosen such that when inserted in the rotor circuit, the maximum torque will be obtained at starting; that is, the speed at which maximum torque occurs, can be regulated by the resistance in circuit with the rotor winding. Figure 7 shows torque curves for a polyphase induction motor with a wound rotor. Curves 1, 2 and 3 show the effect of successive increases of rotor resistance when the rotor is run on the part of the curves a to b, for here there is a decrease of speed due to the increasing of the torque as load is increased.



FIGS. 8 AND 9. DETAILS OF ROTOR CONSTRUCTION

The output of induction motors like transformers, is limited principally by the heating effect due to the various losses which occur when the motor is loaded. The principal loss is that due to the resistance of the primary and the secondary conductors, although hysteresis and eddy current losses enter into the case if the motor is not properly designed. If the induction motor is overloaded considerably, the rotor currents react excessively on the stator, causing excessive magnetic leakage along the air-gap, greatly lessening the torque between the rotor and the stator. If the overload is sufficiently great, the torque will be reduced to such an ex-

tent that the motor will stop. Usually, however, an induction motor may be loaded for short periods beyond its full-load capacity without danger of undue heating.

Stators of induction motors are built up of soft steel laminations which are slotted and the coils are laid in in a manner similar to that of a direct-current armature. In fact, with the exception of the manner of connecting, the stator resembles a direct-current armature turned wrong side out. The rotor slots are usually partially closed at the periphery and a wooden wedge is inserted in the slot over the insulated bars as shown in Fig. 8. There are several methods of connecting the end rings to the bars of the rotors, the 2 principal methods being shown in Fig. 9. The first is for small motors up to about 5 hp. and consists of soldering the ring into the slotted ends of the bars. The second method is a combination of screw and soldered connections as shown in the lower figure.

Shafts for induction motors are usually made exceptionally heavy for a given horsepower owing to the small air gap. The stator frame which contains the primary iron, forms the main supporting casting of the machines and is provided with feet and end bells, the latter supporting the bearings. Two-phase and 3-phase motors are similar in design, the essential difference being in the method of connecting the windings of the stator.

It is essential that an induction motor have a high power factor, otherwise for a given load an excessive current will be required. The air gap is also important as the magnetizing current depends largely upon its length. Mechanical clearance is all that is required, and for small motors up to about 5 hp. 1/32 in. should be sufficient, if the mechanical design is good. For motors from 10 hp. upward the air gap varies from 1/16 to 3/32 in.

Watt-hour Meters*

USE OF TRANSFORMERS AND METHODS OF MEASURING POWER IN ALTERNATING CURRENT CIRCUITS. BY O. H. HENSCHEL

WHEN the capacity of the circuit is over 200 amp., series instrument transformers of such ratio of transformation that 5-amp. meters may be employed are generally used. On voltages over 440, series transformers are almost always used, regardless of the magnitude of the current, in order to insulate the meter from the line; in such cases, potential transformers are also used to step the voltage down to 110.

TEST LOADS

IF CONVENIENT, the load used during a test may preferably be that under which the meter operates. It is, of course, desirable when making any test, that the load be maintained at least approximately constant, a condition hard to obtain in some cases. When such is the case, the only thing to do is to provide some form of artificial load which, for small-capacity meters may consist of a bank of lamps capable of giving a load equal to 1½ times the full-rated capacity of the meter and so arranged that any desirable percentage of full load may be obtained. For high-capacity meters, the most desirable load may be obtained from some form of water rheostat.

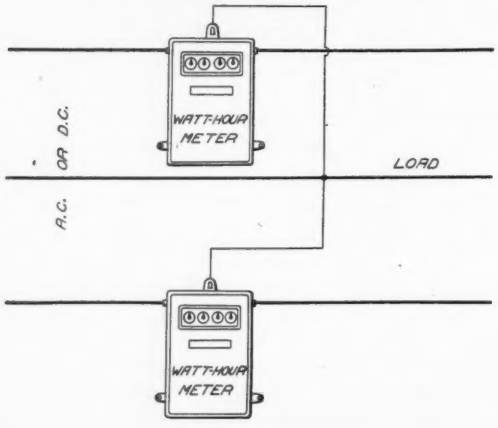


FIG. 11. MEASURING ELECTRICAL ENERGY ON 3-WIRE DIRECT-CURRENT CIRCUITS BY MEANS OF 2 WATT-HOUR METERS

MEASURING OF POWER

IN 2-WIRE and single-phase alternating-current work, but one meter is used connected as shown in Fig. 1.

For 3-wire direct-current circuits, 2 wattmeters connected as shown in Fig. 11 may be employed, although meters are on the market constructed to care for both sides of a 3-wire circuit. When 2 instruments are used, the total power in watts is equal to the sum of the readings, in watts, of the individual meters.

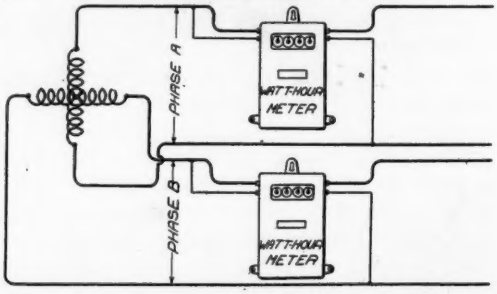


FIG. 12. USING 2 METERS ON 2-PHASE 4-WIRE CIRCUITS

When measuring power on 2-phase 4-wire balanced circuits only one meter need be installed, the total power delivered in this case being equal to 2 times the reading of the one meter. With unbalanced circuits, it becomes necessary to use 2 meters as shown in Fig. 12, in which case the total power delivered is equal to the sum of the readings of the 2 instruments.

For 2-phase interconnected circuits, 3 meters connected as shown in Fig. 13 can be used, the total power being the algebraic sum of the 3 readings. This connection is correct under all conditions of load, balance and power factor.

*Continued from page 1136, Dec. 15 issue.

Some 2-phase circuits are provided with but 3 wires, under which conditions 2 meters should be used connected as in Fig. 14, the total power being the algebraic sum of the 2 readings.

Under balanced load conditions, the total energy delivered by a 3-phase circuit may readily be measured by one meter. In Fig. 15 is shown one scheme of connection used, the meter being inserted as illustrated.

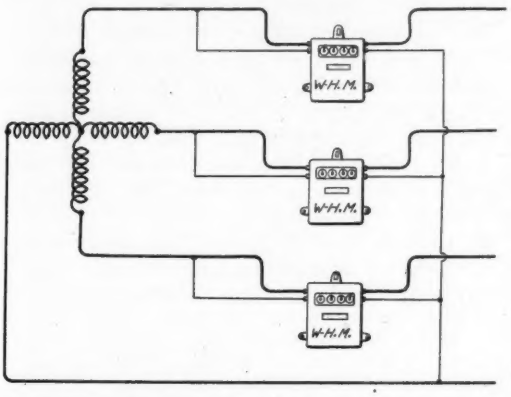


FIG. 13. USING 3 METERS ON 2-PHASE 4-WIRE INTERCONNECTED CIRCUITS

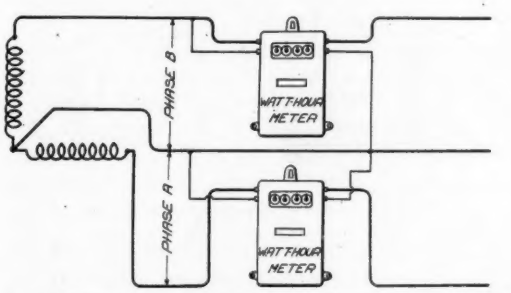


FIG. 14. METHOD OF CONNECTING 2 METERS ON 2-PHASE 3-WIRE CIRCUITS

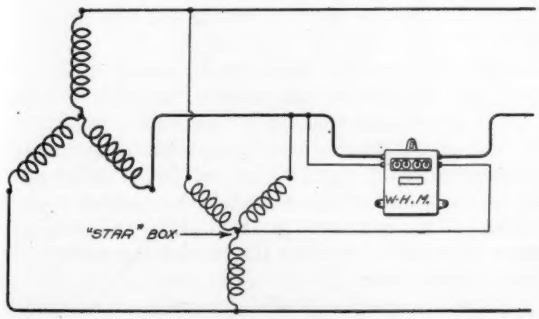


FIG. 15. USING ONE METER WITH "STAR" BOX ON 3-PHASE 3-WIRE CIRCUITS

One potential lead is connected to the same main as the series coil, while the other is connected to a "star" box or artificial neutral, the resistance of each leg of which should be non-inductive and small as compared with that of the potential circuit of the wattmeters, so that the current taken by the latter will not disturb the potential at the neutral point. The total power in this case is 3 times the reading of the meter.

Another method of using the single wattmeter on 3-phase circuits is by the use of the "Y" box shown in Fig. 16 and is similar to the "star" box except that one leg of the star is replaced with the potential circuit of the meter. The total power is 3 times the meter reading.

A third scheme is the "T" reactance coil connected as in Fig. 17 and in which instance the total power is twice the wattmeter reading.

Figure 18 illustrates the use of 3 meters on a 3-phase, 4-wire circuit, a method of connection applicable under

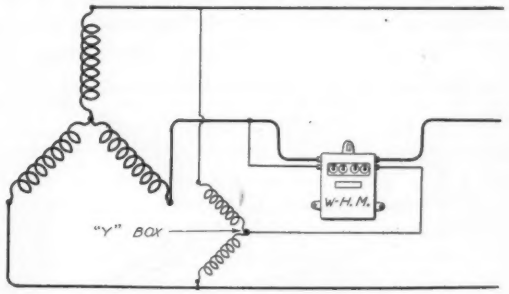


FIG. 16. USING ONE METER WITH "Y" BOX ON 3-PHASE 3-WIRE CIRCUITS

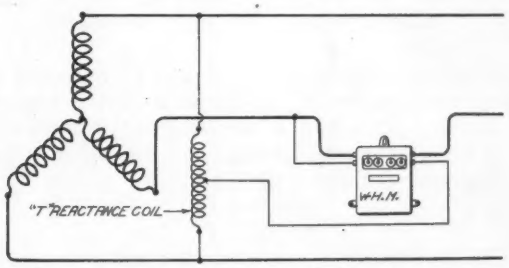


FIG. 17. ONE METER USED WITH "T" REACTANCE COIL ON 3-PHASE 3-WIRE CIRCUIT

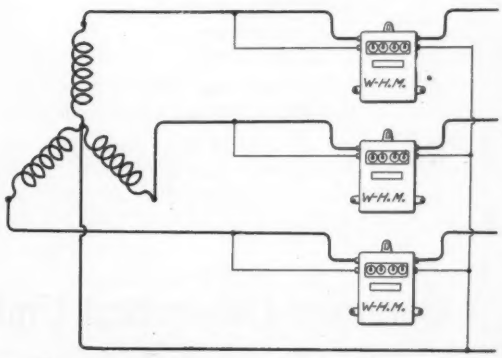


FIG. 18. THREE METERS ON 3-PHASE 4-WIRE CIRCUIT

all conditions of load, balance and power factor. The total power is the algebraic sum of the readings of the 3 instruments.

One of the most generally employed methods of measuring the power in 3-phase, 3-wire alternating-current circuits is by the use of 2 meters with their current coils connected in 2 of the mains and their potential coils connected from each of these 2 mains to the third main. This is shown in Fig. 19. With this scheme of connections, at unity power factor each instrument will indi-

cate ½ the total power and at 50 per cent power factor one instrument will indicate the total power, the other instrument reading zero. At less than 50 per cent power factor, one instrument will read negative.

The total power is, therefore, the algebraic sum of the 2 readings. The proof of this is given by Franklin & Esty in their Elements of Electrical Engineering, in which they state: "Let the positive directions in the mains 1 and 2 and in the 3 receiving circuits be chosen as shown by the arrows in Fig. 19. These directions are chosen symmetrically with reference to the 2 wattmeters in order that each wattmeter reading may be considered as positive when it represents delivered power. Let e', e'' and e''' represent the instantaneous

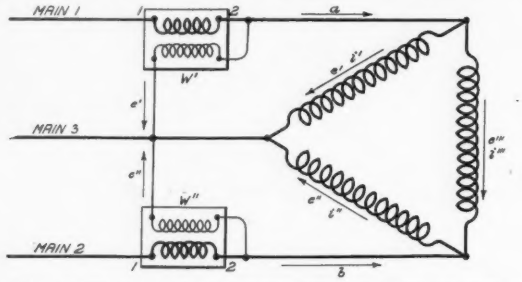


FIG. 19. MOST GENERALLY EMPLOYED METHOD OF ENERGY MEASUREMENT ON 3-PHASE SYSTEMS

values of the voltages, let i', i'' and i''' represent the instantaneous values of the currents in the receiving circuits, and let a and b represent the instantaneous values of the currents in mains 1 and 2 as shown. Then, taking proper account of signs we have:

$$a = i' + i'''$$
$$b = i'' - i'''$$

The reading W' of the upper wattmeter is equal to the average value of the product of the current a in its current coil and the voltage e' across its voltage coil. That is:

$$W' = \text{average } ae'$$

and similarly

$$W'' = \text{average } be''$$

Substituting the above values of a and b in the expression for $W' + W''$ we have:

$W' + W'' =$ average $e'i'$ + average $e''i''$ + average $(e' - e'')\, i'''$, but $e' - e''$ is equal to e''', so that:

$W' + W'' =$ average $e'i'$ + average $e''i''$ + average $e'''i'''$.

A Contrary Generating Unit

RAPID STARTING AND LACK OF OIL CAUSE VALVE SETTINGS TO SLIP; DOUBLE GROUNDS ON CIRCUITS CAUSE GENERATOR TO MOTOR. BY T. G. THURSTON

FOR a long time, considerable trouble was experienced with the valve setting of a 2400-hp. cross-compound Corliss engine, direct-connected to a 500-v. direct-current generator, found to be out of order each time the engine was indicated. No one around the plant could account for this peculiar action until a new assistant engineer, having heard of it, determined to carry on a quiet investigation just to satisfy his curiosity.

He found that the operators in starting this engine failed to open the throttle-valve drain, neglected to give the cylinders any oil, and that they brought the engine up to speed quite hurriedly. The next morning he started up 15 min. earlier than usual, but before doing so had opened the throttle drain to remove all water which may have lodged there since the engine had been shut down last. He also gave the cylinders a liberal dose of oil with the hand pump.

This treatment eliminated the trouble which apparently had been caused by the engine having been started too fast and not giving the parts time to warm up sufficiently, which, together with the accumulated water coming from the throttle and washing away the little oil which may have been there, caused the valves to stick and work unnecessarily hard, move on their stems and change their setting.

At another time, this same unit upon being shut down showed a marked tendency to run away. The regular procedure in shutting down was for the switch-

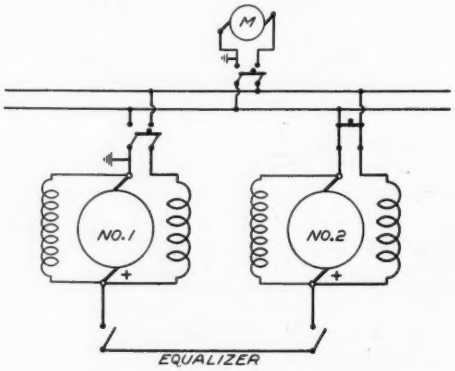


DIAGRAM OF CONNECTIONS SHOWING GROUNDS WHICH CAUSED GENERATOR TO MOTOR

board operator to reduce the load as much as possible by means of the field rheostat, signal the man at the engine to close the throttle, cut in the rest of the field resistance and pull the main switch. The moment this was done, the brushes would spark and the engine would speed up. At first it was thought that this was due to a leaky throttle or receiver bypass valve; but such was not the case because, after some little experimenting, we discovered that by pulling out the equalizer switch, joining this unit with another, the speeding up disappeared. This convinced us that, after all, the engine was not at fault, but that the trouble lay somewhere in the electrical end.

After a search for possible grounds, short circuits or interconnections the electricians found 2 grounds as shown in the cut. One of these was caused by a line having come into electrical contact with some steam piping and the other by one side of a hoisting motor lead touching a water pipe. From the accompanying diagram it may readily be seen that as long as the main switch on machine 1 was out and the equalizers in (machine 2 working), a complete circuit was formed from the equalizer connection of machine 1 to that of machine 2 through the armature and shunt winding of machine 1 to ground; and then again from ground to

machine 2, causing machine 1 to operate as a shunt motor and speed up with an increase of shunt field resistance.

When the equalizer switch on machine 1 and the main switch on motor M were open, this artificial circuit was broken and no further trouble existed. Removing the 2 grounds eliminated the trouble entirely.

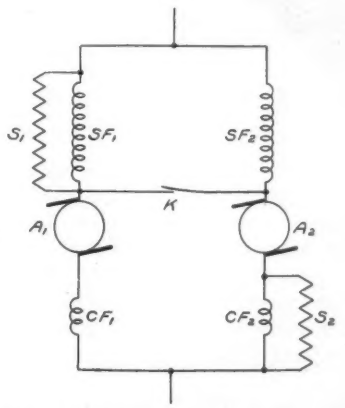
At another time, when starting the engine, there began a terrific pounding in the low-pressure cylinder, coupled with a groaning and grinding of the valves. It was evidently a case of too much water, but no one could figure out where this could come from. There was a trap on the receiver and also a drain which had been left open all night while the engine was shut down. The engine exhausted into a common header connected to a barometric condenser and there was no possibility of the water coming from this source. The next morning the same thing happened. This time a more thorough investigation was made. One of the men noticed that the pipe from the drain valve on the receiver had been extended to a sump in the basement and this, which ordinarily was always full of water was now quite low. He called the engineer's attention to it, who at once came to the conclusion that the water had been drawn into the receiver by the vacuum, although the valve appeared closed. Removing the bonnet from the valve, they found the disc gone. This solved the puzzle. The steam fitter who had extended the line to the sump had put an elbow and a piece of pipe on the end, placing the outlet several inches below water level in the sump. When the engine was started in the morning, the drain valve was, of course, shut and the bypass valve on the throttle opened a little, which, with the vacuum, kept the engine slowly turning over. During this period, there was a vacuum in the receiver and the water was drawn in through the broken disc. When the engine was speeded up and the receiver pressure came up to normal, the pulsations of the exhaust from the high-pressure side carried the water over into the low-pressure cylinder.

U. S. Civil Service Commission announces an examination, Jan. 25, 1916, for designer for hulls and upper works, to fill a vacancy in the Engineer Department at Large for duty with the Experimental Towboat Board at Cincinnati, at an entrance salary of $2400 to $3000, duties, to make computations and detailed plans and designs for the hulls and upper work of Mississippi River towboats and to supervise the work of the draftsmen, computers, and others who may be employed under the appointee, and the actual work of construction later. Applicants must have had at least a standard high-school education or its equivalent and not less than 12 yr. experience in connection with the design or construction of hulls or upper works, of which not less than 3 yr. must have been in making the computations and detailed plans and designs for the hulls and upper works of vessels, at least 2 yr. of which must have been of a responsible supervisory character. Applicants must have reached their thirtieth, but not their fiftieth birthday. Apply for Form 2118, stating the title, Designer of Hulls (Male).

Shunt Out of Place

By E. C. Parham

CONTINUOUS-CURRENT, compound-wound generators, even if of similar design and of like capacity, will not divide the total load equally in parallel operation unless they are compounded approximately to the same degree: this means that the series-field shunts will be approximately the same for the same brush shift on both machines. Owing to the compounding effect of the commutating poles, these are automatically considered at the time of adjusting the compound of such machines. Even if the greatest care is taken in adjusting the compounding of individual machines, if they are afterward required to operate in parallel, it may be necessary to refine their adjustments of shunt and of brush-shift. Where the machines are to be used as exciters, their load is near and line drop is negligible and it is customary to flat compound them at the switchboard; furthermore, if automatic voltage regulators are to be used, the series field shunts are so adjusted as to give a sight undercompound at the switchboard.



WITH SERIES-FIELD SHUNT ACROSS THE COMMUTATING FIELD, SATISFACTORY PARALLEL OPERATION WAS IMPOSSIBLE

An operator has 2 compound-wound commutating-pole exciters that he had for months used singly with satisfaction. In trying to operate them in parallel, however, he could not do so to advantage because one tended to overload.

The accompanying diagram indicates the connections responsible for the condition. In the diagram, A_1 and A_2, SF_1 and SF_2, CF_1 and CF_2, S_1 and S_2 are, respectively, the armatures, series fields, commutating fields and series-field shunts of the 2 machines. It will be noted that the series-field shunt of machine 2 is connected across its commutating field instead of across its series field; this not only gave unequal degrees of compounding, but it also unbalanced the equalizing circuits. Upon placing the shunt where it belonged, the machines equalized all right.

In making wire rheostats, wires smaller than No. 21 A.W.G. must be wound on an insulating core, between No. 21 and No. 6 A.W.G. spiral coils are used, for larger currents No. 6 wires may be used in parallel, as it is difficult to wind heavier wire.

Foundation Anchor Bolts---VII

Method of Specifying Bolts on Foundation Drawing. By Terrell Croft

LOCK washers are sometimes applied as shown in Fig. 1, between nuts and machinery bedplates, in cases where the machine is subject to vibration which will soon "rattle" off a nut unless the lock washer were inserted. A locknut can be used instead of a spring washer, but the time required for manipulating a second

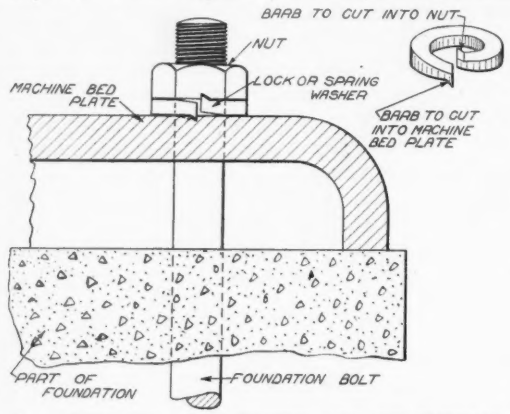


FIG. 1. SPRING OR LOCK WASHER AND ITS POSITION ON FOUNDATION BOLT

nut must in some cases be considered where it is necessary to remove a machine and replace it with another one in a minimum of time. This feature must frequently be considered in steel mill and other industrial plant installations. As shown in Fig. 1, the ends of the spring steel lock washer normally flare out, so that, when the nut is turned down on it, it presses the 2 ends until they lie in the same plane as shown in the assembly view. The washer then acts like a compressed spiral spring and presses with a constant force against the bedplate and the nut, and thus prevents the nut from loosening.

Locknuts and Their Application

Locknuts should be used on practically all foundation anchor bolts unless spring washers are applied. A locknut is merely another nut which may be square, but preferably hexagonal, screwed on top of the first nut with considerable force, but not so hard as is the main nut. If a locknut is properly applied it will lock both nuts securely in place.

Extending Anchor Bolts

Extending the anchor bolts of an old foundation involves certain reconstruction. Such extensions can ordinarily be made, and Fig. 2, detailing a typical case, indicates the usual procedure. The illustration shows, in dashed lines, an old foundation. The full lines indicate the new foundation. The letters A show the position of the old anchor bolts, while the letters B and D indicate the new positions. The new foundation as shown at 1 extends but a relatively short distance above the floor line, which distance is insufficient to accommodate anchor bolts for the new machine of such lengths that they would provide the requisite resistance to withdrawal,

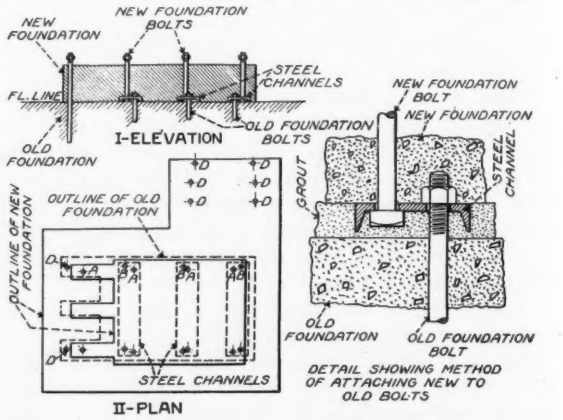


FIG. 2. METHOD OF INCREASING SIZE OF FOUNDATION AND EXTENDING OLD BOLTS

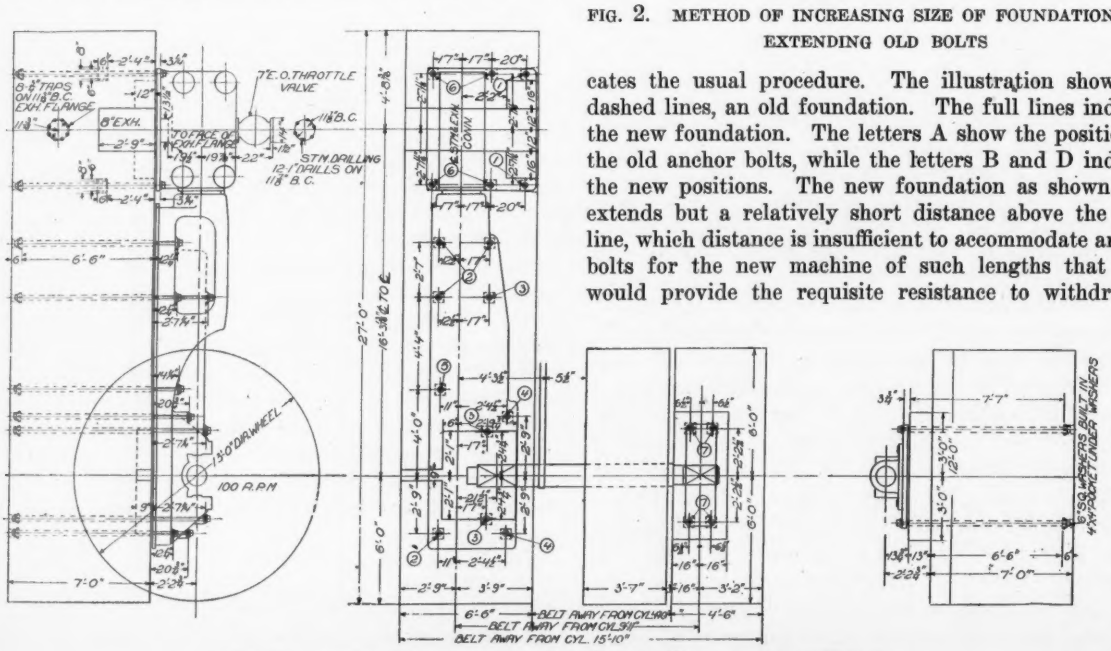


FIG. 3. FOUNDATION DRAWING FOR 20 BY 42-IN. CORLISS ENGINE

hence it is necessary so far as possible to tie the new bolts to the old ones, thus making them act together.

The old machine bedplate rested on the floor, hence the old anchor bolts, B, projected about 3 in. above the top of the floor. Over the projecting ends of each pair of old bolts lengths of properly drilled channel were placed with the new bolts inserted through holes in these channels. The channels and bolt heads were then grouted securely in place as indicated. Then the new concrete foundation was cast around the new bolts, a templet being provided to hold their upper ends in correct relation. The bolts D and D came outside of the old machine and over depressions in the floor necessary in connection with the old machine, hence it was possible to use bolts of the usual lengths for these, and to get them in the usual manner.

Specifying Anchor Bolts

On drawings a certain practice, which will be described, is in use by many of the machinery manufacturers in this country. Before the bolts can be specified, it is desirable to prepare a scale drawing of the machine or prime mover on its foundation, as shown in

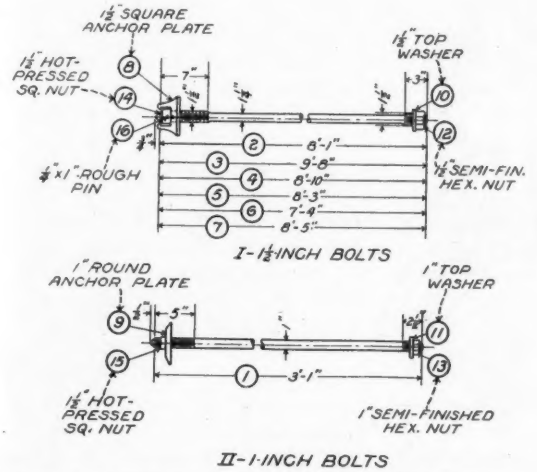


FIG. 4. METHOD OF LISTING FOUNDATION BOLTS

Fig. 3. An effort should be made so to lay out the foundation that the fewest possible sizes of foundation bolts will be necessary. That is, from this standpoint, the ideal anchor bolt specification would be one that called for all of its bolts of the same diameter and length. It is seldom feasible to lay out a large foundation so that such simplicity can be realized, but an effort should be made in that direction.

Then the anchor bolts should be numbered on the foundation drawing as shown in Fig. 3; for example, all of the bolts of one length and diameter should be numbered 1, all of the bolts of another length and diameter 2, and so on. This being done, a combination bolt drawing, Fig. 4, should be laid out as part of the foundation drawing tracing which will show dimensions of all of the anchor bolts required. It should show also the nut washers and anchor plates; in fact, should indicate the complete anchor bolt equipment. Then the drawing of Fig. 4 should be reduced to a schedule like that of Fig. 5, which anybody not familiar with mechanical drawing can readily decipher. This schedule will indicate just how many of each of the items of each size nuts, bolts, washers, anchors, etc., are required. It might seem that the schedule of Fig. 5 is a duplication of the drawing of Fig. 4. In one way it is, but, on the other hand, the schedule summarizes all of the information relative to material required for anchor bolts, which summation cannot be ascertained from the drawing itself without spending a certain amount of time. It is apparent from a study of Figs. 3, 4 and 5 that each of the reference numbers with the circles; that is, 1, 2, 3, etc., refers in each of the 3 instances to one specific part.

Aluminum is the most abundant of all the metals. In the form of its oxide, alumina, it constitutes about 15 per cent of the earth's crust, according to the United States Geological Survey. Yet until recent years it was a curiosity; there were only a few hundred or few thousand pounds in existence, and its value was $14 to $15 a pound. Within a generation it has become very useful, now selling at about 20 cents a pound. The entry of aluminum into the field of useful metals came with the discovery that it could be extracted from the mineral

ITEM	NO. WANT	SIZE & NAME	MAT.	PATT. NO.	DWG. NO.	STOCK STD.	STOCK OTHER
①	2	1"x3'-1" FOUNDATION BOLT				2316	
②	4	1½"x8'-1" " "				2335	
③	3	1½"x9'-8" " "	W.I.-A				
④	2	1½"x8'-10" " "	" "				
⑤	1	1½"x8'-3" " "				2336	
⑥	4	1½"x7'-9" " "				2327	
⑦	4	1½"x8'-5" " "				2338	
⑧	18	1½" BOTTOM WASHER SQUARE				2296	
⑨	2	1" " " ROUND	C.I.-D	SE. 7565	227-165		
⑩	18	1½" TOP " "				842	
⑪	2	1" " " "	SS.-C		127-17		
⑫	18	1½" S.F. HEX. NUT				377	
⑬	2	1" " " "				373	
⑭	18	1½" H.P. SQ. "				413	
⑮	2	1" " " "				410	
⑯	18	⅜"x1" ROUGH PIN	STL.				

FIG. 5. TABULATION OF FOUNDATION BOLT MATERIAL WHICH SHOULD APPEAR ON FOUNDATION DRAWING

bauxite, a claylike substance. This mineral itself is by no means plentiful, but known deposits are sufficient to make aluminum an important competitor of certain metals, such as copper and tin, in a good many lines of work.

Already aluminum has displaced steel in certain classes of construction where strength is required in combination with extreme lightness, such as in the manufacture of flying machines. An alloy known as duralumin, containing about 95 per cent of aluminum, is claimed to have qualities as good as those of good Bessemer steel, although it is only ⅓ as heavy. This alloy possesses great hardness when annealed, and its melting point is above 1200 deg. F. The great future of aluminum lies in the perfection of a process whereby it can be commercially extracted from the unlimited deposits of alumina—rich clays and rocks, which exist in all parts of the world. The day which shall yield really cheap aluminum holds out boundless possibilities. The chemist or investigator who can devise the needed process of extraction will not be forgotten by succeeding generations.

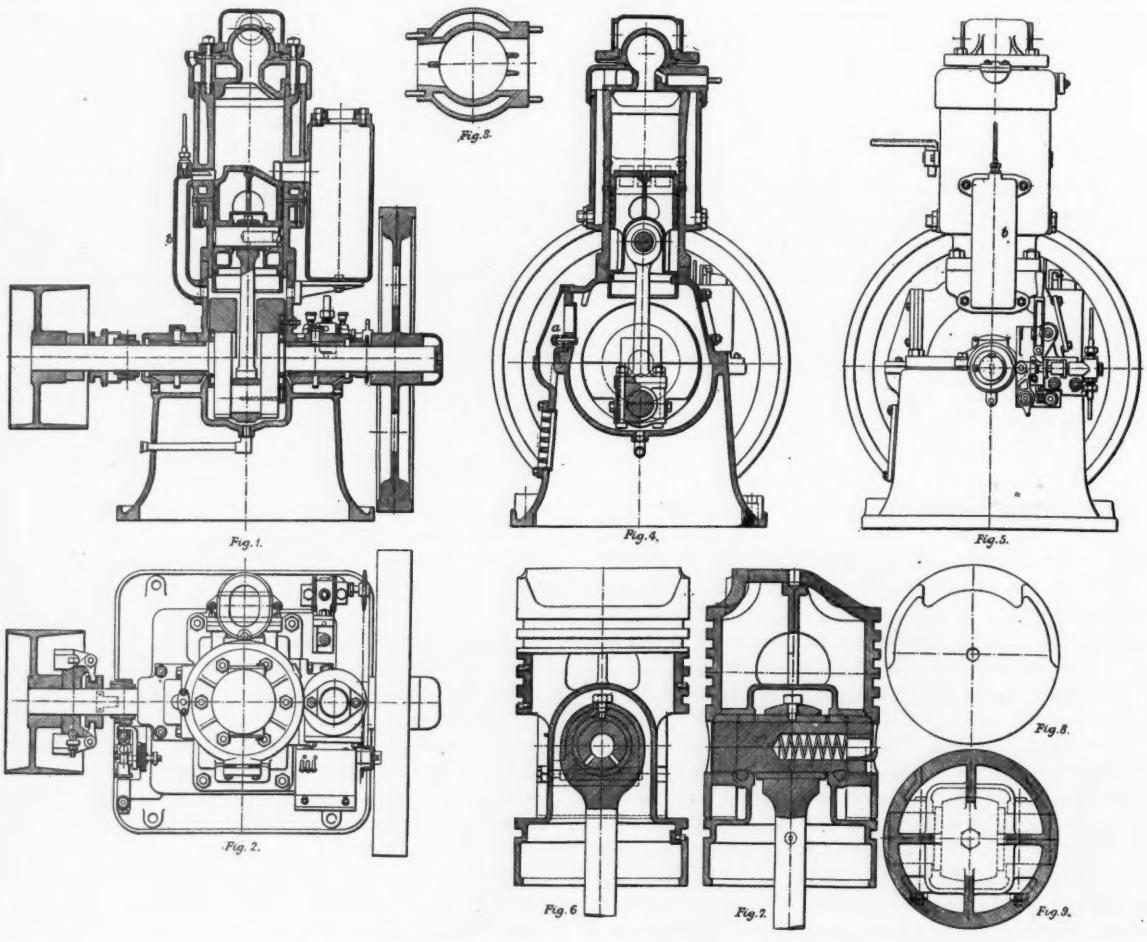
GAS POWER APPARATUS

Producers, Engines and Industrial Applications

Martin's 2-Cycle Semi-Diesel Engine

DESCRIPTION OF NEW ENGLISH ENGINE EMPLOYING THE HOT BULB SYSTEM OF IGNITION

THE well-deserved popularity of the 2-cycle hot-bulb or semi-Diesel engine is directing the attention of designers towards the perfecting of this type of prime mover. The chief objection to the type—mainly, the fact that in early examples it proved rather uneconomical compared with the 4-cycle engine—has been gradually reduced, if not actually removed, while other advantages often prove exceedingly attractive. In many quarters, when an engine is run intermittently, the actual fuel consumption, providing it is within reasonable limits, is not a deciding factor. Such points as ease of starting, reliability, etc., are often much more important. In this respect the hot-bulb semi-Diesel engine has an undoubted advantage over some other forms,



FIGS. 1 AND 2. LONGITUDINAL SECTION OF 2-CYCLE SEMI-DIESEL ENGINE. PLAN VIEW
FIG. 3. HORIZONTAL SECTION ACROSS CYLINDER
FIGS. 4 AND 5. CROSS SECTION. END VIEW WITH BELT PULLEY AND GOVERNOR REMOVED
FIGS. 6, 7, 8 AND 9. LOWER SECTIONAL VIEW OF PISTON. SECTIONAL VIEW OF PISTON PARALLEL TO GUDGEON PIN. GENERAL VIEW OF TOP OF PISTON. CROSS SECTIONAL VIEW OF PISTON

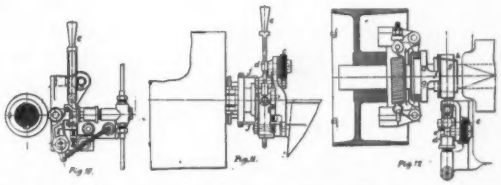
and it is little wonder, therefore, that it has been rapidly improved since it was first taken up seriously a few years ago.

The engine shown in the accompanying illustration gives 9 b.hp., and has a single cylinder, 7 in. in diameter, the stroke being 8 in. The normal speed is 475 r.p.m. Figure 1 shows a longitudinal section, Fig. 2 being a plan. Figure 4 is a cross-section, and Fig. 5 an end view with the belt-pulley and governor removed. Figure 3 is a horizontal section across the cylinder. The piston is shown in detail in Figs. 6 to 9, while Figs. 10 to 12 show the fuel pump and governor gear. As in other 2-cycle machines, this machine compresses the scavenging air in the crank-case. It is drawn in through a grid in the base, and passes up through a passage shown at *a*, in Fig. 4. It is drawn into the crank-case through a flap-valve, which is adjustable, so that the degree of compression can be regulated. On the down stroke of the piston the air is forced into the cylinder through the passage *b*, to be seen also in the outside view, Fig. 5. On entering the cylinder it strikes against the piston, is deflected upwards, and then passes out to the expansion box, carrying the products of combustion with it.

It will be seen that the lower part of the crank-case is solid with the engine base. To the base is bolted the upper part, above which is fixed the cylinder. The cylinder and head are interesting. The head is fixed to the cylinder, but fits over the jacket-walls, with which the joint is made by means of a rubber ring, as in the jacket of gas-engines. Thus independent expansion of the cylinder and jacket is provided, and only one metal-to-metal joint between the cylinder casting and head has to be made. The head is water-jacketed. It contains a moderately wide neck, opening out for the bulb, which is a separate dome-shaped casting. The hot bulb is not bolted down, but is held down by the cover, which forms a ring pressing evenly all round on the flange of the hot bulb. These features have contributed considerably to the complete elimination of hot-bulb failures, so common an occurrence in some engines of the 2-cycle type. Another interesting point often overlooked is the desirability of placing the scavenging and exhaust-ports in line with the crank-shaft. It will be seen from the illustrations that this is done in the engine under notice. Often they are placed on a line at right angles to the shaft, and therefore reduce the area of the wearing-face provided in the cylinder for the piston at a point where the thrust is severe. Figure 3 is a section taken across the ports, the exhaust-port being shown in dotted lines in Fig. 4, as well as in other views.

The piston is shown in Figs. 6 to 9. It is of the long-trunk type, of cast iron. It is fitted with 5 piston-rings, and with one snap-ring at the front end. It is designed in such a way as to prevent as much as possible the heat of the cylinder passing down to the crank-case. With this object the piston-head is provided with an insulating air-chamber, which also protects the gudgeon-pin and little end from the heat in the cylinder. This insulation keeps the heat in the crank-case down, the big end cool, and generally improves the running by facilitating lubrication. The gudgeon-pin is case-hardened steel, ground parallel to fit. It is kept in place by 2 wedge-bolts, which hold it hard against the upper side of the piston. The wedge-bolts are drawn in by nuts on their small screwed ends. No harm can come if the nuts should by any mischance come off, as they cannot either foul any ports or gain access to the crank-chambers. The gudgeon-pin is lubricated with oil taken from one of the 2 forced-feed supplies to the inside of the cylinder at positions shown in Fig. 1. It is taken into the pin by a brass wiper kept against the cylinder wall by a spring. The arrangement is shown in Fig. 7.

The regulating and governing gear, shown in Figs. 10 to 12, are among the most interesting features of the engine. The regulating and governing is effected by varying the stroke of the fuel pump. The engine is regulated by turning the small knurled wheel *c*. This wheel is mounted on a bracket, and on the end of its spindle is a small eccentric bearing against the stem of the pump-starting handle *e*. The adjustment of the eccentric regulates the length of the outward movement of the fuel pump plunger, and therefore the amount of fuel drawn into the pump and subsequently sent to the cylinder. The small wheel *c* is fitted with a ratchet which holds it in any desired position. In running,



FIGS. 10, 11 AND 12. GENERAL VIEWS OF REGULATING AND GOVERNING GEARS

the supply is effected by the pump driven by a cam on the main shaft through the rocker *f*. The governing varies the fuel supply by altering the stroke of the pump. This is accomplished by altering the throw of a cam or eccentric. The manner in which this is done will be clear from Figs. 10 to 12. The cam surface actually in contact with the roller on the rocker *f* is the wide periphery of the eccentric *g*. This eccentric is a good sliding fit on a skew cylinder *h*, keyed to the shaft. A feather prevents *g* from revolving on *h*. It will be clear that the eccentricity of *g* is capable of extremely fine adjustment, by movement in a direction parallel with the main shaft. The required control of the position of *g* is from the governor weights through the clips *j j*, which engages with a groove in *g*. In connection with the pump there is a safety-stop, which prevents the pump-plunger being given a stroke in excess of that required for full load capacity. This stop consists of a plate *k*, in which are 2 slanting slots. The slots pass over 2 fixed studs. The plate stands out far enough to foul the pump-plunger head, and therefore limits the outward stroke. The adjustment of the plate is obtained by a set-screw underneath it, the studs and slanting slots above referred to, causing the plate to move towards, or away from, the pump, thus shortening or lengthening the stroke, as the set-screw is screwed down or up. The set-screw and studs can be clamped, and the plate thus locked at the full load position. Should anything happen to the adjusting screw,

or the locking become loose, the plate can only fall and reduce the fuel supply to the cylinder. Failure, therefore, is on the safety side.

Force feed lubrication is provided for the cylinder, gudgeon, and the crank-pin. The cylinder oil is supplied through 2 small drilled ports over-run by the piston-rings at the bottom of the stroke. Near the open end of the trunk piston there is an oil groove just above the snap-ring. The crankpin is supplied with oil from the force feed lubricator. The oil is forced into a centrifugal ring oiler, mounted on the crank-shaft, which delivers oil through a hole drilled in the crank. The bearings are ring-oiled. Water circulation is by pump, chain-driven, and with a free-wheel sprocket, so that it is unaffected by pre-ignition, should such take place.

The engine has a large expansion-box attached just outside the exhaust-port. The flywheel is of the disk type. The belt pulley which accommodates the shaft governor is furnished with an outside sheet-iron cover, while at the other extremity a neat cap is placed over the end of the crank-shaft, covering in the flywheel key. The engine is started by a blow-lamp, and will start up in about 3 min. from the cold on crude oil, and in 5 min. on paraffin. The water injection is regulated by hand.

ENGINEERING.

Lignite Gas Producers

THEIR THEORY; OPERATION OF PRODUCERS; ENGINES OPERATING ON LIGNITE. BY GEORGE W. MUENCH

ONLY a small per cent of all the gas producers in operation in the United States are using lignite for fuel. In fact, statistics show that in 1912 only 4.4 per cent of all producers operated on lignite; yet the field for lignite producers is enormous. In some sections of the country where we have large lignite fields, water power is also plentiful, which has to a great extent prevented the development of the lignite producer in those sections. This is particularly true in the State of Washington, where good producer lignites are plentiful, but the abundance of water power gives low rates for electric power. In spite of this, however, lignite producer plants are in operation, most of them successfully. Many gas producer failures have been directly due to lack of competent help. Many lignite plants have not been as successful as they should have been because of too small a producer, in other words, an over-rated producer. No matter how perfect the plant, no installation is absolutely automatic, so that competent operators are necessary.

In order to be a competent gas producer operator, it is necessary to know a little about the chemistry of combustion, which is the underlying principle of the producer. The object of this article is to give the operator a little theory together with some practical pointers found by experience.

PRINCIPLE OF OPERATION

THE SIMPLE chemistry of the gas producer is not difficult and involves only a few common elements and only a few of their compounds. The chemistry of combustion of the boiler furnace is not unlike that of the producer and gas engine combined. In the furnace, gases are formed and immediately burned. In the producer, there must be no burning of the gases, as this is done in the engine itself. In the boiler, the products of combustion, as the burnt gases are called, escape through the smokestack, while in the gas power plant the products of combustion escape through the engine exhaust pipe.

The fuel inside the producer is arranged in layers, called "zones," as follows: On the grates is a shallow layer of ash; above this is a zone in which the actual combustion takes place and for that reason is called the combustion zone. Above this is a zone in which some of the important chemical changes take place that give us the combustible gases which the engine needs; this is called the decomposition zone. Above this is the last or distillation zone. Here the coal partly undergoes a distilling process, where some more valuable gases are formed. In the combustion zone the temperature is the highest and gradually decreases as the top of the fuel bed is reached. In each zone a definite chemical action takes place. Taking, for example, an up-draft suction producer, air and steam are drawn up through the various zones and the producer gas, a mixture of various gases, leaves the producer near the top. Of course, the exact composition of this final gas differs with the different classes of fuel. Lignite gives a rich gas, but not so many cubic feet per ton as do the higher grades of coal. Because of the high percentage of volatile matter in lignite, the up-draft type of producer gives a gas with a considerable percentage of marsh gas, while the down-draft type does not form so much.

On entering the producer, the air is drawn through the ash bed and then strikes the hot combustion zone. Here the oxygen (O_2) of the air combines with the carbon (C) of the coal to form carbon dioxide (CO_2). This CO_2 passes next into the decomposition zone where it combines with the carbon of the coal to form carbon monoxide (CO). If sufficient air had been taken into the producer, there would be an actual burning process in this zone, because enough free oxygen would be present to cause the CO to burn, combining with the free oxygen. This must be prevented.

The air consists approximately of 1 part of oxygen and 4 parts of nitrogen (N) by volume, but we have used only the oxygen. Oxygen itself does not burn, but is absolutely necessary to have combustion. The nitrogen passes through the entire depth of fuel without undergoing any change or combining with other elements, so that this free nitrogen will again be present in the gas as it enters the engine. So far, then, as the air is concerned, the chemical changes that have taken place are shown chemically as follows:

$$C + O_2 = CO_2;\ CO_2 + C = 2CO.$$

If air only were drawn through the fire, the temperature would rise to a point where clinkers would be formed and fuse onto the producer lining. In order to

prevent this, steam is drawn through the fire to keep the temperature down. Chemically, steam is water (H_2O), hydrogen (H) and oxygen. When water vapor or steam comes in contact with hot carbon it is broken into these 2 elements. The hydrogen passes on through the producer and enters the engine, and if not too much is present it is desirable. The liberated oxygen combines with the CO_2 to form CO, just as occurred with the oxygen of the air. These changes may be expressed chemically as follows:

$$2H_2O = 2H_2 + O_2;\ 2C + O_2 = 2CO$$

or both expressed by one formula, $H_2O + C = CO + H_2$.

Now we have left the distillation zone in which the distilling process forms marsh gas (CH_4). This gas burns and is also desirable to have, and is easier to handle in the engine than the hydrogen.

Before considering the operation of the producer, it may be of interest to note first what happens to the gas in the engine. Here the spark ignites the gases and the burning of the gases mixed with air causes the following chemical changes:

$$2H_2 + O_2 = 2H_2O;$$
$$2CO + O_2 = 2CO_2;$$
$$CH_4 + 2O_2 = 2H_2O + CO_2.$$

The nitrogen has not changed. The CO_2 and the H_2O are called the products of combustion. The more CO_2 present in the exhaust gases the better.

These chemical conditions will not be the same continuously unless the air and water adjustments are always relatively the same. However, load conditions often change suddenly and vary between wide limits, so unless the water vapor and air are immediately controlled some troubles will result.

Operation

With lignite as fuel the question arises as to what should be the size of the coal used. Either nut or pea size is good. Nut size is used mostly and is undoubtedly better for the new operator, as pea coal is more wasteful unless properly handled.

Lignite slacks badly. It should, therefore, never be allowed to lie in the open in the summer time, because it gradually crumples into small pieces. Before unloading it should be well wet so as to avoid this action.

Lignite burns freely so that the rate of fuel consumption may be quite high. Plants are in operation that consume every hour as high as 40 lb. per sq. ft. of fuel bed area. It is difficult to give any definite figures as to the proper depth of the fuel bed; but it should be deep enough to change all the CO_2 into CO, and to prevent overheating and burning of the gas and the formation of clinkers.

When a plant is operating 24 hr. a day, 30 days in the month, the methods of operation must be decidedly different from those employed when operating only part of a day or when Sunday can be used for repairs on engine and producer. The big problem in many plants operating continuously is the time that may be allowed for working the fire as well as how often the fire should be worked and how often the producer should be charged. This must to a great extent be determined at each individual plant, as in no 2 plants are load conditions and engine and producer conditions just alike.

In some plants, the engine is sensitive to any slight change in producer conditions; in other plants, the fire can be worked almost at will without affecting the engine seriously.

The writer recalls an operator saying: "Anybody with a little common sense can operate a producer plant 8 to 10 hr. a day, but it takes a man to operate a 24-hr.-a-day plant." In more ways than one, he was right.

As to how often the producer should be worked when operating continuously, no definite periods can be set for all plants. In some plants, the fire gets some attention every 2 hr., and in others, the fire is worked and the producer charged every 6 hr. If the load is light, it is often possible to allow 8 hr. between workings. As far as possible, all operations should be performed at regular intervals. Not too much time should be allowed for working the fire, charging and drawing the ash, so that a minimum amount of air will get into the producer, especially if the engine is sensitive to changes of load. Where the plant is in operation only 8 or 10 hr., the fire is put into good condition in the morning before the plant is started and again given a working after shutting down in the evening. If necessary to work the fire during the day, as a rule the noon period is a good time, when the load is low.

The fire should be worked enough to get the clinkers out, or at least dislodged from the fire-brick lining. Plenty of ash should be removed. Enough ash must, however, always remain on the grates to prevent the grate bars from warping, due to overheat. As a rule, the fire need not be worked at all from the top unless clinkers have formed or if the fuel is hanging. The clinkers must be worked toward the grates and then removed from below. If clinkers have formed, they must be removed as soon as possible. The clinker is the producer's worst enemy. It ruins the lining; it causes unequal draft through the fuel bed, which, in turn, causes the gas to burn in the producer. Forcing the producer will surely cause clinkering, and under such conditions the operator has a hopeless battle. Clinkering can be greatly reduced by introducing into the producer the proper amount of steam. Up to the present time, the proper amount of steam can be determined only by trial. Naturally the moisture present in the fuel must be considered. Lignite is extremely high in moisture. Not enough steam causes too high temperatures with resultant burning of the gases and clinkering. Too much steam causes too low temperatures, preventing the making of good gas; also too much hydrogen in the gas, causing engine prematuring, and no worse engine trouble could possibly be had. The proper amount of steam is important and its regulation must be carefully watched.

The new operator is more likely to have trouble due to overworking the producer than not working it enough. Overworking the producer is wasteful of fuel, keeps the hot zone too shallow and does not keep enough ash on the grates. Not working the producer enough causes the hot zone to rise too high, which causes the gas to burn in the producer, as well as clinkering. If too long intervals between workings are allowed, the engine will most likely give trouble during the time of working the fire.

When using lignite the gas washing apparatus must be very efficient as the large percentage of volatile matter produces enormous quantities of tar, especially with the up-draft producer; with the down-draft type all the tarry matter is drawn through the hot zone, which changes a portion of it into fixed gases. When using tower scrubbers it is of great importance to have sufficient water. When using rotary scrubbers, usually called centrifugal tar extractors, it is, of course, also necessary to have sufficient water, but besides this it is important to have necessary speed, which should be at least 1000 r.p.m. Not less than 2 gal. of water per hp.-hr. should be used for thoroughly washing the gas.

All possible provisions should be made to make cleaning easy in case of tar trouble. All turns should be crosses or tees with blank flanges, so that it will not be necessary to remove pipes for cleaning purposes. The pipes from the producer should drain toward the producer. If cleaning becomes necessary it is best to do it in the daytime. If cleaning is done at night, no open lights should be brought near the pipes unless it is certain that no explosive mixture can possibly still be in them.

In some lignite plants, centrifugal tar extractors only are used. If something should go wrong with them, or if the motor driving them causes their shut-down for 30 min. or more, it is not good to keep the plant running without the tar washer even that long.

If the gas is used for metallurgical purposes, or under boilers, or for other heating processes, it is not necessary to remove the tar from the gas; in fact, the tar represents a large proportion of the heat value of the gas.

When a plant operates only part of a day, it is, of course, necessary to put the producer into condition for the night. After shutting down, work the fire and then charge the producer. It will need no further attention until next morning. The air intake must be at least partially closed. If closed entirely, the fire may get so low that it will take too long a time to get the plant in operation again. The amount the air valve should be open must be determined by trial. If steam is taken into the producer from a separate boiler, it is essential to have this shut off, otherwise the steam will kill the fire during the night. If the producer is properly handled the night standby loss will be small.

Operation of Engines

Engine troubles should not exceed nor differ much from those experienced with any internal combustion engine operating on gasoline, distillate, city gas, or other fuels. The one decided difference between an engine equipped to run on producer gas and one to run on liquid fuel or higher heat value gas is in the compression. This should be in the neighborhood of 140 lb. per sq. in. for good lignite gas. With this compression, if too much steam is taken into the producer, the excess of hydrogen that will then be in the gas will cause prematuring. The new operator usually has a little trouble starting the engine, because as a rule he is too hasty. No attempt at starting should be made until good gas has been obtained. The gas should burn at the try cock at the engine with a blue flame, and should continue to burn after the match used for lighting has been removed. Neither should the flame flicker and gradually go out, as that shows still too much air in the gas. Better to wait a little too long than not long enough, and then be certain that the engine will start, at least that the gas is ready for its starting.

A gas plant is not dangerous. If for any reason excess pressure forms in the scrubbers or producers, the water seal will be blown out and all that is necessary is to refill this. The one caution in working around a producer plant is to avoid working in a poorly ventilated room. The CO of the gas is a deadly poison and must not be breathed. If repairing or overhauling while gas is escaping, at least 2 men should be on the job so that if one is overcome the other one can get him to the fresh air.

Extension of foreign trade is a policy now occupying the thought of most business men of the United States, whether it affect their individual activity or as a matter of general interest. In line with this thought, the Chamber of Commerce of the United States has submitted to referendum vote of its members, commercial organizations, boards of trade and local chambers of commerce in 42 states, District of Columbia and Hawaii several questions of government policy of immediate importance. On every question the vote was affirmative of the recommendation of the Committee of the Chamber of Commerce of the United States, standing approximately 870 for and 20 opposed on all items.

The policy as thus favored, and which will accordingly be furthered by the Board of Directors of the National Chamber are as follows:

1. Increase in staff and appropriations for the Bureau of Foreign and Domestic Commerce to cover administration, editorial work, collecting and translating foreign tariffs, distribution of information and correspondence.

2. Appointment of a Director of Field Service of the Bureau, with enlarged appropriations for collecting and exploiting samples and for adequate traveling and living expenses abroad.

3. Increased appropriations for immediate and special investigations in Latin America.

4. Appointment of new commercial attaches to the more important countries where embassies and legations are now maintained covering Italy, Scandanavia, Spain, Austria, Japan and Turkey.

5. Creating the position of trade commissioner to perform the same duties as commercial attaches, but to be sent to the smaller countries or groups, and colonies of larger countries, covering New Zealand, South Africa, British India, Greece, the Balkan States, East Indies and Central America.

6. Continuance of 8 present branch offices of the Bureau but no additional offices to be established.

7. Appointment and promotion of members of the field service in accordance with Civil Service Law.

8. Elevation of 11 consular agencies to consulates and establishment of 15 new consulates, with adequate clerical assistance, and adequate and frequent inspection of consular offices.

9. Renewal of publication of statistics of internal commerce by the Bureau.

Friction of Water in Pipes and Elbows

CALCULATING CHARTS USED FOR RAPID ESTIMATING. BY ERIC H. PETERSON

IN dealing with problems relating to friction of water in pipes and elbows, which is an important item in reference to pump problems, I have prepared charts and found them convenient. The following example will show the usefulness of the charts, given in the Practical Reference Tables:

Example.—Find the total head in feet for a pump to elevate 410 gal. of water per min. 60 ft. high, through a 5-in. pipe, 150 ft. long, and containing 3 elbows.

Solution.—The total head is equal to the elevation in feet plus the friction loss, expressed in feet of head.

In the pipe friction chart trace from the point 410 at the bottom, indicating "gallons water per minute" vertically to the curve marked "5-in. pipe," then horizontally to the left, where we read 4 ft. of friction loss per 100 ft. length of straight pipe; thus for 150 ft. length of pipe, the friction loss is $150 \div 100 \times 4 = 6$ ft. of head.

Then from chart of elbow friction we find, by tracing as is shown by the arrow line, that for 410 gal. p. m. the friction for one 5-in. elbow is 0.67 ft. of head; thus for 3 elbows the friction loss is $3 \times 0.67 = 2.01$ ft. of head.

The total head for this pump is therefore $60 + 6 + 2.01 = 68.01$ ft.

The friction is also given on the charts in pound pressure per square inch.

For determining the right size of pump for a certain size of double pipe ammonia condenser, the charts have also proved very handy; the return bends are then considered as two 90 deg. elbows.

Occasionally the contracting engineers insist on getting the friction resistance specified for the water pipe in double pipe condensers. The following example will show how easy a problem of that kind is solved with help of the charts.

Example.—Find the resistance for the water to pass through a double pipe ammonia condenser, consisting of 10 sections, each 10 pipes high and the length of the 1¼-in. water pipes being 20 ft. 5 in. centers. 150 gal. water to be circulated through the condenser per minute.

Solution.—Assuming the 10 sections grouped in one battery, we get one-tenth of 150 gal., or 15 gal. p. m. for each section of the condenser. Each section contains 5 return bends on the back end and 4 return bends on the header end, making 9 return bends on each section, which is the same as 2×9 or 18 90-deg. elbows. Further, the amount of pipe in each section is 10×20, or 200 ft. of 1¼-in. pipe.

Thus from the chart we find that for circulating 15 g. p. m. through a 1¼-in. pipe, the friction loss is equal to a head of 4.7 ft. or 2 lb. per sq. in., all for 100 ft. length of pipe. For 200 feet of pipe the friction is two times that for 100 feet of pipe. Thus in this case the friction in the pipe is 2×4.7, or 9.4 ft. of head, or 2×2 equal to 4 lb. pressure per sq. in.

From the elbow friction chart we find, that for circulating the same amount of water through a 1¼-in. elbow, the friction loss is equal to 0.3 ft. of head, or 0.13 lb. per sq. in. Thus for 18 elbows the friction is 18 times more, or $18 \times 0.3 = 5.4$ ft. of head, or $18 \times 0.13 = 2.34$ lb. pressure per sq. in.

The friction loss in this condenser is therefore $9.4 \times 5.4 = 14.8$ ft. of head, or $4 + 2.34 = 6.34$ lb. pressure per sq. in.

To find the horsepower required to overcome the friction in this condenser, we can either figure the power necessary to raise 15 g. p. m. 14.8 ft. high and multiply this with 10, which is the number of sections in the condenser, or figure the power necessary to raise the total amount of cooling water per minute 14.8 ft. high. For instance, in the case cited above, the friction loss expressed in horsepower is

$$\frac{150 \times 8.33 \times 14.8}{33{,}000} = 0.56 \text{ horsepower}$$

8.33 being the weight of one gallon water in pounds.

This is the theoretical horsepower.

The brake horsepower is, assuming an efficiency of 80 per cent, equal to

$$0.56 \div 0.80 = 0.7 \text{ horsepower.}$$

The charts are based on Weisbach's formula.

—Refrigerating World.

"Grease Balls" in Boiler

THE accompanying illustration shows an interesting and somewhat unusual deposit taken from a boiler. When feed water enters a hot boiler the carbonates of lime and magnesia the feed contains are precipitated, and if the circulation in the boiler is not too active, the precipitated matter often floats on or near the surface of the water for a time, in light flocculent particles. If oil or grease is also present in the boiler, the floating carbonates are likely to combine with the organic part of it, forming a sort of soap having lime and magnesia as a basis instead

UNUSUAL FORM OF DEPOSIT TAKEN FROM A STEAM BOILER

of the usual soda or potash. The soap thus formed is insoluble and sticky, and the motion of the water sometimes causes it to collect into solid masses varying from mere pellets up to spherical balls of considerable size. The "grease ball" that is shown above was formed in this way, and is about 3 in. in diameter. When "soap" of this kind comes in contact with the boiler, it is likely to adhere to it and form a nonconducting coating, which keeps the water away from the metal and so gives rise to overheating of the plates or tubes, which are then likely to bulge or collapse.—The Travelers Standard.

LETTERS DIRECT FROM THE PLANT

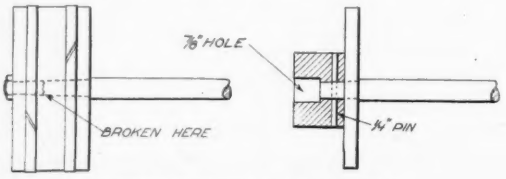
Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Pump Troubles and Remedies

A STEAM PLANT of which I took charge had one boiler feed pump and it was not connected up. They fed the boiler from city water pressure when they had enough pressure, but when the pressure was weak or off they had to shut down.

The manager was asked why he did not have the pump connected up so he could use it. I was told that the pump was out of order and several attempts had been made to operate it, but all had failed.

On going over the pump, it was found that the discharge valve plate was made of light brass and it was sprung in the center. After getting it straightened out by means of a hard block of wood and a few sledge hammer blows, it was put in place, connected up, steam was admitted and it was found to be O. K. and moved off on its mission of feeding the boiler.



BROKEN PISTON ROD AND REPAIR

Once a small float pump would not work; after taking off the water cylinder cap and discharge valve plate, it was found that the gasket for discharge valve plate was made the same as the water cylinder cap; after making a new gasket, the pump worked fine.

A small 2½ by 1½ by 3-in. duplex pump had a very hard knock on one side at each end of the stroke. The brass water cylinder lining was of a close fitting type and it had worked loose and not having a new lining on hand, the lining was pulled, a hole was drilled through cylinder casing and tapped for ⅜-in. cup end set screw, the lining was put in place and set screw tightened against it and this pump has been in continual service for several years past and is still in use the same way.

The plungers of a 6 by 4 by 6-in. outside center packed boiler feed pump were of cast iron. The feed water had a corrosive effect, which ate and pitted the iron badly. Some bronze tubing was ordered and these plungers were put in a lathe and turned down to fit the tubing, also the glands were bored out and bronze liners put in them; this put the pump in fine shape, and the cost was very small considering the fine service we got from the pump afterwards. The bronze cost 29 cents a pound and 19 lb. were used for the plungers and 5 lb. for the 4 glands. Having our own lathe, there was no machine shop bill.

One morning a 4½ by 3 by 4-in. pump would not start. Taking off the steam cylinder head, we found that the piston rod was broken in two between the piston body and steam piston follower, and as this was the only pump we had, repairs had to be made at once, so the piston rod was taken out, and a hole for a ⅞-in. bolt was drilled in about halfway through the piston body. It was then tapped for a ⅞-in. bolt. The piston rod extending through halfway, a ¼-in. hole was drilled through the piston body and piston rod and a pin put in to hold the piston rod in the piston body and a ⅞-in. bolt was threaded long enough to reach from the center of the piston body to the outside of the piston follower for the nut outside; the hole in the steam piston follower was reamed out large enough to go over the ⅞-in. bolt. It required about one hour's work to repair this pump, which has been in operation for the past 3 yr.

A. U. WOLFE.

Cost of Poor Packing

REFERRING TO the article by N. G. Near, page 1145, of the issue of Dec. 15, 1915, in the formula for the Cost of Packing, there is a figure 550 in the denominator, while in the application of the formula, 550x32 is used.

I do not understand where this 32 comes in as a part of the divisor, and also, I am unable to see on what basis this formula is worked out. I would be glad to have further information. M. E. KANIC.

This question is answered by the author of the article as follows:

In the formula mentioned, there should have been a symbol "*g*" in the denominator, defined "acceleration due to gravity," which has a value of 32.16, or roughly 32. The substitution in the application of the formula was correct, as is also the answer given.

The formula is based on scientific principles, and while I do not claim it to be absolutely correct, it is close enough for practical purposes. The development is, briefly, as follows:

Approximate kinetic energy stored in a flywheel is usually taken as; $W V^2 \div 2 g$.

This is approximate because weight of the flywheel arms is neglected, but this is not a large error.

Dividing this by the time required for the engine to come to rest, we get the "average" energy dissipated per second after closing the valve, as; $W V^2 \div 2 g T$.

Since the deceleration of the flywheel is practically constant, the condition is like that of a body thrown vertically into the air, and to get the rate of dissipation of energy at the beginning of the stop, we must multiply by 2, which gives; $W V^2 \div g T$.

Dividing by 550, we have a rational formula for the friction horsepower of the engine;

$$\text{F. hp.} = W V^2 \div 550\, g\, T.$$

A good packing will result in longer stopping time, since the friction is less. This has been called T., and the friction horsepower would be about 13.5, under conditions given in the problem, while the stopping time for T_2 would give a friction horsepower of about 14.65.

The good packing would, therefore, save the difference between these, or 1.15 hp., which multiplied by $0.01, the cost per horsepower-hour, and by 3000, the horsepower-hours per year, gives $34, as per the problem worked out in the previous issue.

The formula, in the form given, comes as a result of taking the difference between the 2 expressions for friction horsepower with the poor and the good packing, multiplying by the cost per horsepower-hour, the hours a day worked and the days a year, to give the cost per year.

The idea is that good packing will permit the engine to run longer after shutting off steam, and the "goodness" of a packing is proportional to the length of the stopping time, so that the formula as given hits the dollars and cents cost fairly close. N. G. Near.

Automatic Ejector Mechanism

The pit wherein our boiler feed pumps are stationed, was prone to become flooded with seepage water, as the water tender had no time continually to watch it. Then, when he noticed the water was getting high, he would open the ejector valve and go away, forgetting it was open. When the water was gone, the ejector continued to blow steam into the sewer until he returned.

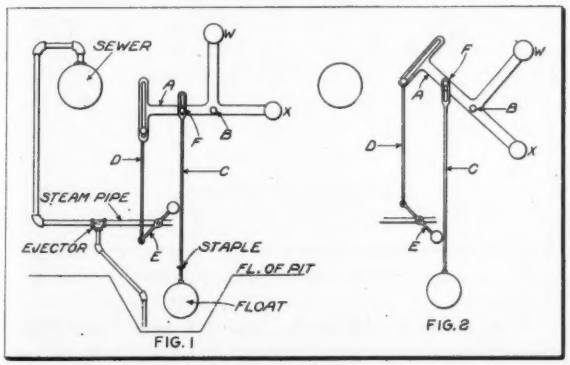


FIG. 1. POSITION OF MECHANISM WITH WATER RISING
FIG. 2. POSITION OF MECHANISM WITH STEAM VALVE OPEN

I made the 3-armed lever, AWX, to turn on the pin B. The yoke arm A is counterbalanced by the weight arm X, so that this member is in a state of balance on the pin B when the arm W is perpendicular; also a float and rod C, and a connecting rod D for the plug-cock lever E, which is also counterbalanced.

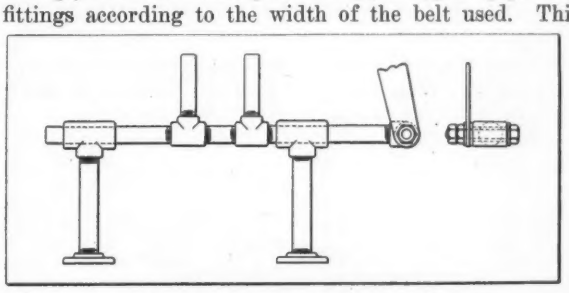
Assume that the steam is shut off and the water is rising in the pit. The bottom end of the slot in the float rod C, is now in contact with pin F. As the float rises it lifts pin F and tips lever A until the weight arm W is to the right of a perpendicular position, when the lever, being no longer balanced, falls into the position in Fig 2.

As the lever begins to fall, the bottom of the slot in arm A picks up the hook on connecting rod D, and work is done in opening the steam cock. While the lever AWX moves of its own accord, the pin F moves through the slot in rod C, and comes to the top of the slot. While the water is being blown out and the float C is pulling AWX over to its former position, the slot in arm A has no influence over rod D, and does not push it down till arm W has again passed the perpendicular and the top of the slot comes in contact with rod D. When this occurs, the steam cock is shut and the cycle completed. All the parts lie flat against the wall and take up no room. H. K. Scholefeld.

Making Belt Shifters

When installing a few machines in a manufacturing plant, it was found that they were not equipped with belt shifters. The accompanying illustration shows the type of shifters that were made which were satisfactory in every respect.

The uprights can be made of ¾ or ½-in. pipe and fittings, and the shifting rod of ½ or ⅜-in. pipe and fittings according to the width of the belt used. This



AN EASILY CONSTRUCTED BELT SHIFTER

type of belt shifter is substantial, easily made and inexpensive. It can be assembled in a short time and can easily be modified to suit necessary conditions. If desired, the shifting forks can be located outside of the uprights, and a coupling used in the shifting rod for a stop. John Leafstrom.

Graphite in the Boiler

Referring to "A Peculiar Experience with Graphite" as described in the Nov. 15 issue of Practical Engineer, on page 1057, there are several points that do not seem to have been brought out in that article which are vital to an understanding of the case.

In the first place, graphite is not soluble in water, therefore it cannot pass out with the steam under normal conditions. The only way that it can get to the linen of a bleachery or to any other point in an industrial plant, is for the boilers to prime, when the graphite might pass out carried by the water in the steam.

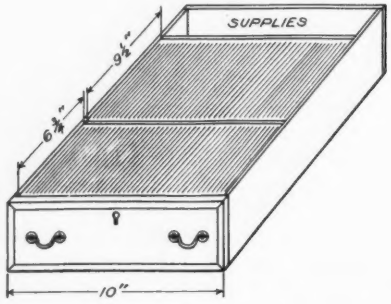
If boilers prime, graphite should not be condemned for that, as any material in the boiler, such as clay, caustic soda or potash will be carried over under similar conditions. This condition of priming is caused by fine particles in solution in the water, and can be prevented by frequent blowing down, so that it is a matter of care to prevent the possibility of priming.

In view of these facts, it seems evident that graphite should not be blamed for the difficulty related in the article referred to, which might have been avoided by making sure that such priming did not exist. Editor.

Combination Filing Cabinet

I HAVE for years been keeping in blank books all sorts of things that would help me in my work and that I wished to remember: Records of the equipment, sizes of gaskets and ring packings, when a rod was packed, what it was packed with and how long it lasted, etc. There were so many of these items that it was impossible to find any particular one without a long hunt. I had about decided to arrange the matter under different heads, get a blank book and copy what I had and add to it from time to time. I wanted something that was inexpensive, elastic and convenient. A loose-leaf book that was well made and would stand the handling would be expensive and soon become soiled and untidy, and every time I wished to consult any item I would have to open up the desk, dig out the book and shuffle it over. So I decided to have a cabinet.

I went to the printing office and bought 100 white envelopes, 3⅝ by 6½ in., and had 500 sheets of paper cut 6¼ by 7 in. These sheets were folded in the center, and with a needle and thread I made books of from 4 pages up to as many as I wanted for any item. Each of these books was slipped into an envelope and I wrote on the top edge the kind of information it contained, as Governor, Dashpots, Safety Valve, etc.



DESK DRAWER PARTITIONED FOR FILING CABINET

I took one of the drawers on the side of my desk and nailed a thin piece of board across the front end, 6¾ in. from the front, and put a bottom 3¾ in. down from the top; this made a filing space 10 in. long, 6¾ in. wide and 3¾ in. deep, which will hold 150 envelopes each with its little book of information, to fill which will take a lifetime, as they are capable of any number of expansions. The envelopes are stood on edge in alphabetical order and any subject is easily found. A great many subjects can be taken in besides your work. I have a book for every department connected with the mill, in which I keep track of many interesting things.

Although the details on file are far from being complete, yet a person can sit at my desk and from information gathered from the books, can read the story of the erection of this steam plant from the time the first shovelful of dirt was thrown out until the present time. He would also learn of the different parts of the equipment —engines, boilers, pumps, traps and dynamos—by whom they were manufactured, when installed, shop numbers, repairs, etc.,—things that are often hard to get. The whole cost of this was 95c plus a lot of hard work.

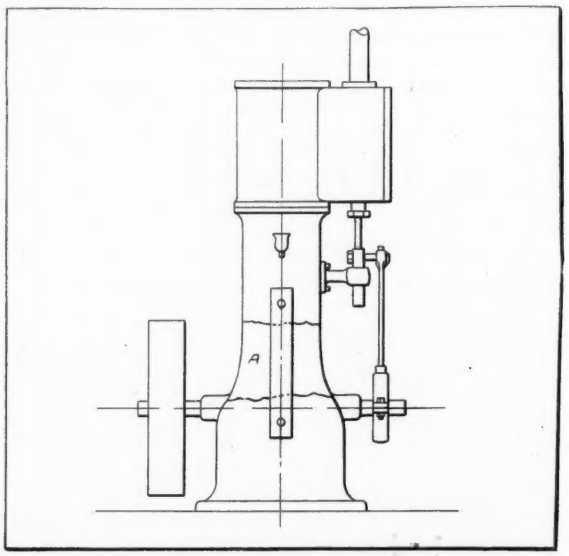
For a cabinet to file clippings, I have put a partition 9½ in. back of the first one in the same drawer and bought some envelopes, 4 by 9¼ in., and arranged them the same as the others. When I read an article that I think may be helpful, I cut it out and file it, and in this way I have a lot of data from my own plant and the other fellow's, too, which will help out in times of trouble. This makes a combination that is hard to beat.

ARBA A. AVERY.

Broken Bolt Causes Engine Wreck

IN A plant where I was once employed, there was a centrifugal pump, belt driven, by a vertical slide-valve engine. The unit was located in a pit alongside the engine room. Its duty was to pump water to a reservoir.

One day when I was making my rounds, I found the engine stopped. Upon examination, I discovered a piece knocked out of the frame on the side of the engine as shown at A in the sketch.



DAMAGED ENGINE FRAME

The cause of the break was that one of the bolts on the crankpin box, which was of the marine type, broke. The other bolt bent and then broke off, thus letting the connecting rod come between the frame and crankpin. As there was not enough room for the connecting rod between the frame and crankpin, the momentum of the flywheel knocked out the piece A.

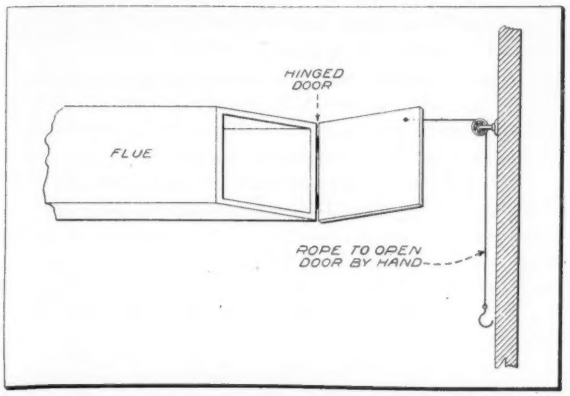
It was repaired by drilling and tapping a hole above and below the piece knocked out. A stud was screwed in each hole. A bar of iron, with 2 holes drilled in it a little less in distance than between the 2 studs, was heated red hot. It was then placed so that both studs were projecting through the holes in the bar, and on cooling it contracted and drew the cracks close together, holding the piece A firmly in place.

The engine was larger than necessary to do the work required, so that this kind of repair was sufficient.

L. K.

Safety Valve on Flues

In the plant where the writer is employed, the original installation was for 8 boilers; in time, 8 more were added, and again 6 more, all on the same stack and to the original flue connection. Sometimes the fire doors would be blown open from gas explosions when starting up on dull, heavy mornings. The writer thought it would be a good plan to make "safety valves" out of the ends of the flues. Since they were applied we have had no more trouble from that source. Simply put a



ARRANGEMENT TO RELIEVE EXCESSIVE PRESSURE IN FLUE

hinge on the ends of the flues and make them into swinging doors, and if there is an explosion and the doors pop open, the draft shuts them automatically, and all danger is eliminated.

When shutting down, noons and nights, operate those doors by a rope and they break the draft and stop coal consumption; also, they save opening the fire doors to keep down steam. All leaks from around fire boxes, and all soot from flues have disappeared since adopting this method. Hugh McMann.

Knock in Cylinder

Knocks in the cylinder sometimes come from an unusual cause. During the past 3 yr., we have had 2 cases which were a little out of the ordinary, and although no serious damage was done one case presented considerable food for thought.

The first case was that of one of the 8 by 5 by 12-in. duplex boiler feed pumps. This pump had been running without any trouble for some time, when it developed a back knock in one side whenever the piston reached the head end of the steam cylinder. It appeared to be the piston striking against the cylinder head or some solid obstruction, although the piston rod did not seem to make a full stroke. The steam cylinder head was taken off and it was found that one of the plugs which are screwed into the 4 holes in the hollow piston casting through which the core is removed after the casting is made, had worked out and lodged between the piston and cylinder head. Figure 1 shows how these pistons are constructed, and also where the plug lodged in the cylinder.

These plugs are placed in all piston castings of the solid type which are cast hollow, but are sometimes so neatly trimmed off that they are not easily found. This plug appeared to have been out some time, as the corners were worn and pounded until the piece looked more like a ball than a plug. On examining the hole, we found the threads to be clean and on further investigation, we found that these plugs were simply ¾-in. solid pipe plugs which were screwed in tight and cut off flush with the surface of the piston.

The other case was that of a high-speed flat balanced-valve engine having a cylinder 13 by 14 in. The cylinder head was made flat on the inside and the piston rod nut, instead of extending beyond the surface of the piston and fitting into a recess in the head when the piston was at the end of the stroke, was let into a counterbore in the piston as shown in Fig. 2. This counterbore had to be quite deep, and large enough to get a socket wrench on the nut. After this nut was drawn up tight, the recess around the nut was poured full of babbit. That was its condition when it came from the builders. For some unknown reason this piece of babbit worked loose and

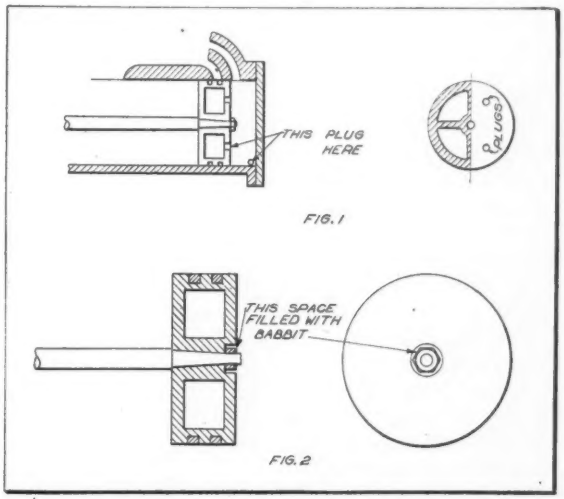


FIG. 1. SHOWING LOCATION OF PLUG RESPONSIBLE FOR POUND IN PUMP CYLINDER

FIG. 2. COUNTERSUNK NUT ON PISTON ROD IMBEDDED IN BABBIT

a piece broke off and fell down into the clearance space between the piston and cylinder head. This piece of metal was originally about the size of a 1-in. nut. When it first dropped into the cylinder the engine pounded very hard for a few strokes or until the piece of babbit had been flattened out into the ¼-in. or less clearance space where it was found when the cylinder head was taken off.

The office of this piece of babbit was the subject for considerable discussion around the plant and as the engine came from the builder in this condition they were asked to explain the reason for its being there. The superintendent of the engine builder's factory disclaimed any knowledge of it, and about the only reason that he could advance for its being put in was that it might have been done when the test was made on the testing floor of the shop to reduce the clearance volume, and possibly lower the steam consumption through the means of smaller clearance space. J. C. Hawkins.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Some Practices to be Condemned

Is it safe to wash a horizontal tubular boiler 1 hr. after pulling a heavy fire and pumping cold water into it to cool it down?

2. Is it safe to get a full head of steam on the boiler in 1 hr. after washing?

3. If the journal boxes on the shaft of a double upright engine are loose enough to allow the crank to drop to the lower center by the weight of the crosshead, will it cause trouble?

4. Give different methods of finding loose crankpins.

5. How tight should crosshead wedges be drawn?

D. O.

Answers.

We would condemn in the strongest terms the practice of hastening the cooling of any kind of a boiler in order to wash it out at the earliest possible moment. Let us look at the proposition as you have outlined in your question and take note of the operating conditions. You have a heavy fire under the boiler and consequently the setting is intensely hot.

The boiler is in a condition of practically equal strain in all its parts, and being a horizontal return tubular boiler, it has about ⅔ of its shell exposed to the fire. You draw the fire and at once pump in cold water to hasten the cooling. This water, being heavier for a given volume than the water in the boiler, will at once settle to the bottom, where it will cause the bottom of the plates to contract suddenly.

This strains every fiber of the metal and is exceptionally severe on the rivets and the tube ends and will cause excessive leaks at these places. Of course, these leaks can be stopped by calking the rivets and rolling the tubes; but while this is the proper method to make these parts tight, every time the process is repeated, it weakens the metal.

Sudden cooling of the boiler is apt to start a fracture in some of the sheets or rivets, which cannot be seen by any inspection that can be made; but repeating the process will generally increase these fractures until, sooner or later, you will have a cracked sheet, either in the body of the sheet itself or from the rivets to the edge of the shell (rivet cracks, or fire cracks). Then, some day when everything about the plant is running along as smooth and placid as a gentle summer evening, there will be a muffled roar and another "mysterious boiler explosion."

Then, again, as soon as the boiler would be emptied, the intense heat of the setting would overheat the shell, causing another sudden change in the metal fiber and at the same time causing mud and other scale forming materials to bake and burn on the interior of the shell, where it will be found almost impossible to wash it off or remove it by any mechanical means.

By all means, use every effort to have at least 10 hr. in which the boiler may cool off gradually and without strain; 24 hr. would be better.

2. The answer to this question will be about the same as for the preceding one as far as strains set up in the sheets and rivets are concerned, only these are naturally not so pronounced. If the boiler is filled by an injector, the water will be at a temperature of about 160 deg., or thereabouts, so consequently the changes in temperature are not so great or so sudden. But it is best to give a boiler time in which to come up to a "running heat" gradually, so that the setting will assume its temperature gradually and thus reduce danger of fracture to a minimum.

3. The fact that the reciprocating parts of one side of a double vertical engine are heavy enough to cause that side to drop to the lower center is evidence that the engine is not balanced. Each side of such an engine should be balanced carefully on the crank of its own side. On small engines such as are used on rough work where care and attention are crude, the manufacturer in casting the crank disc makes a rough guess as to the weight of the reciprocating parts and inserts a certain amount of metal in the disc (also by the same rule of thumb), which is generally much too little rather than too much.

Some makers are so careless as to insist that double engines with cranks set at 180 deg., should balance each other. So they will on a balancing roll or other device used for the purpose where dead weight only is concerned; but the instant that the engine is in operation and the inertia of the moving parts comes into play, as well as centrifugal force acting on the wheel, or the unbalanced disks, each side acting as an unbalanced unit will soon pound the bearings to pieces.

Part of the vibration can be eliminated by proper valve setting, and even if the reciprocating parts are properly balanced, improper valve setting will cause vibration and wear on all bearings.

4. If the engine has a complete oil guard about the reciprocating parts, it is impossible to locate a loose crankpin by sound alone, for the reason that the guard acts as a reflector and makes the sound not only of a loose pin, but of any other part requiring attention, appear to be somewhere else than where it really is. So if it appears that the crankpin is loose, first find out by the usual methods of "rocking" the engine (if the valve gear will permit), whether the trouble is in the boxes, shoes, main bearing, or piston.

A crankpin that is loose and makes itself known when the engine is in operation, may not reveal itself by the "rocking" method; but if you can get the engine on the top quarter where the back of the pin is visible,

you may see a little ring of grease well worked up and black, where there is play between the pin and the hole.

Still, even this evidence may be lacking. If it is, wash the back of the pin off carefully with gasoline or benzine till perfectly clean and free from oil or grease. Apply a little kerosene and let it stand for a few hours. Then, when the rocking method is applied, the kerosene will show on the surface where the crack is. If you find it necessary to apply the test soon after applying the kerosene, first wipe the surface off clean with a dry cloth.

Another method is to disconnect the crankpin boxes, and tap the pin sidewise with a soft hammer, meanwhile holding the finger of the other hand close against the junction of the pin and the disk. If you have a sensitive touch, you can detect any looseness in the pin. A tight pin when struck a sharp blow with a light hammer will give forth a clear ringing metallic sound; a loose pin will give a sound not so clear and metallic.

5. This is a question where one must understand the operating conditions in order to know just how tight the crosshead shoes should be adjusted. The writer has adjusted shoes on Corliss engines running from 100 to 175 r.p.m. to within 0.003 in. with complete success. As a matter of fact, the closer the shoes can be run within reasonable limit the better the engine will run, since the reciprocating parts will be kept more nearly in line.

On engines having the load applied through the piston rod, such as tandem air or ammonia compressors, pumps, etc., where the weight of the wheel assists in carrying the load as the steam in the cylinder is being reduced through expansion, the crosshead will "flop" unless the adjustment is close.

Whether or not the engine is in line, or the guides worn (be they bored, slipper or bar guides), determines the adjustment to a certain extent. If worn, adjust to the tightest place, not to the loosest one. If there is much dirt or grit flying about, don't be too particular about close adjustment. Use care and good judgment.

GEO. H. WALLACE.

Heat Value of Fuel Oil

I WOULD LIKE to know how to test the fuel oil used by Diesel oil engines for the per cent of sulphur and also for the efficiency. C. D. C.

A. Where you ask how to determine the efficiency of fuel oil, we assume what you really desire to know is how to determine the heat value of this oil. In a paper read before the American Chemical Society, by A. C. Sherman and A. H. Kropff, the authors state that from the results of a large number of experiments they have been able to deduce the following formula:

$$\text{B.t.u.} = 18{,}650 + 4\ (\text{Baume} - 10).$$

In this formula, B.t.u. is the calorific value of fuel in British thermal units per pound. Baume is the density of the fuel as rated by Baume hydrometer.

This method is, as you will readily see, one which will give but approximate results, still we are sure it will serve your purpose. In order to determine accurately the heat value of any fuel—whether it be solid or liquid—it is necessary to use some form of calorimeter made for that purpose.

2. The amount of sulphur present in the oil may be determined in the following manner:

A sample of 50 cc. is put in a flask and 0.5 grams of sodium bicarbonate is added. Heat is applied to the mixture and it is distilled at the rate of about 50 drops per minute until about 45 cc. has been driven off. The residue is then placed in a large porcelain dish and is washed several times with petroleum ether. The ether is collected from the several washings and evaporated. About ½ gram of sodium is next added in small pieces, the whole is evaporated over a small flame until it becomes sirupy and then is ignited. The ignition is continued until the ash is quite white, ammonium carbonate being added gradually during the operation. The residue is treated with a little diluted hydrochloric acid and barium chloride is added, precipitating barium sulphate. The precipitate is separated by filtration losses, ignited and weighed, and the amount of sulphur contained in it is calculated by multiplying its weight by 0.137,33. The weight of sulphur divided by the weight of the original sample and multiplied by 100 gives the percentage of sulphur in the oil. O. H. H.

Jumpers in Motor Armatures

IF HALF the coils were taken out of the armature of a 10-hp. direct-current motor and jumpers put in between every other coil, what would be the result? Would the speed be increased? Would the power be increased?

G. M. L.

A. It would mean 2 things: First, the motor would have to run at twice the former speed in order to generate the required counter electromotive force; second, there would probably be a considerable heating of the brushes, because, although with jumpers put on, the brushes would be getting the same amount of commutator bearing, there would be a greater tendency to sparking as the coils pass out from under the brushes. There would be no effect on the power of the motor, but this would be quite inadvisable to attempt. One or 2 coils may be cut out and a jumper put on for emergency running, but this should only be done temporarily.

A. L. R.

Boiler Operating Questions

WHY DOES impure water give wetter steam than water containing no impurities? Why does dirty water cause a more violent agitation of the steam and water as steam is being generated?

2. What is the cause of girth seams developing fire cracks in the overlapped sheet next to the fire?

J. W. D.

ANSWERS

IN THE CASE of impure water in a boiler, so far as is learned from the study of boilers with glass shells, the impurities are carried up with the bubbles of steam in the circulation of the water, and as these bubbles break from the surface of the liquid, the particles go up with them and carry drops of water surrounding each particle of the impurity. This water mixes with the steam in the steam space, and thus causes a greater amount of moisture to be carried on than would be the case if the steam bubbles broke from the surface without the impurities present. This is also the cause of the more violent agitation of the steam and water. It is not a case of any particular kind of impurity, but simply of

solid particles circulating with the hot water and being thrown up into the steam space.

2. As to the fire cracks in girth seams, the difficulty is largely one of the settling of scale-forming material along the unevenness of the seam, thus cutting down the heat transmission to the water at this point, and permitting local overheating. Of course, at the point where there is a seam, the transmission of the heat from the fire to the water is less perfect than in the single plate, because of the greater thickness of material, and the addition of the scale which is caught by the edge of the plate and the rivet heads only adds to this difficulty.

A. L. R.

Repairing Firebox Cracks

IF A CRACK 3 in. long came in the fire box of a locomotive boiler, between the stay bolts, and it was covered by the fire, how would you have it repaired?

A. L. F.

A. In case a small crack develops in the sheet of a firebox, a good way to repair it is to examine closely for the ends of the crack, and having found them, drill and tap at one end so as to remove entirely the end of the crack and screw in a plug. Beside this drill another hole on the crack, so that the edge of the drill will just cut clear, in the first plug.

Tap this and screw in another plug, and continue this operation until you have drilled out the crack and replaced it with a line of plugs, each of which is tapped partly into the one preceding it.

These plugs do not need to be large, say, not over ¼-in. pipe tap, and it is not necessary to let them project very much on the inside of the sheet. Use ordinary stay bolt rods of the proper size to thread for the pipe tap you wish to use. Use a little white lead when screwing the plugs in, and peen each a little when completed and after all are in, carefully peen the entire surface of the plugs as exposed.

G. H. WALLACE.

Steam Header Design

HEREWITH IS a sketch showing tentative layout of steam headers which is contemplated in the redesign of an old street railway plant with which I am connected. A question has arisen as to what size header should be used and what steam velocity in feet per minute is advisable under normal conditions.

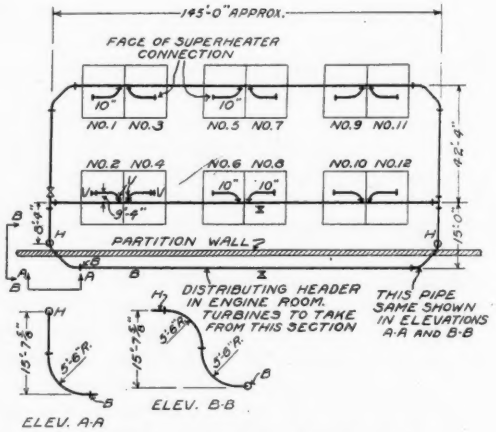
For figuring the size of pipe, it is assumed that 10 of the boilers are on the line and operating at 200 per cent of builders rating. This makes 20,000 hp. supply steam at 185 lb. gage and 130 deg. F. superheat, all of which must flow through the sections marked H on the sketch. In my opinion, the pipe should be 14 in. internal diameter, which gives a velocity of approximately 230 ft. per sec., although some opinions call for a 12-in. internal diameter.

Of course, for a 12-in. pipe the loss due to radiation will be less than for a 14-in. and the pressure drop will be greater. The velocity can be reduced from 230 ft. per sec. by cutting in a connection at XX as shown on sketch; but even if this were done, would you consider 12-in. pipe large enough?

G. E. W.

A. In looking over the drawing, it appears that there is a section at each end of the boiler room which you have marked "H," 15 ft. in length, which seems to be the section in question.

Such a short length of pipe could probably stand the high velocity without serious loss in pressure, but if the steam is taken from the center of the distributing header, or near it, you will probably find, with the 12-in. pipe, considerable drop in pressure. Steam velocities as high as 15,000 ft. per min. are quite common in plants where the steam is superheated and turbines are installed, and velocities somewhat higher are frequently employed.



LAYOUT OF BOILERS AND HEADERS

The 12-in. pipe will give a steam velocity, under the conditions you have named, of approximately 19,000 ft. per min., while the 14-in. pipe would give 13,800. If you installed the connection you have marked, this, of course, would reduce the steam through the sections HH, and give you a velocity which is not at all infrequent.

The size of pipe is determined largely by the allowable pressure drop, and this depends both upon pipe size and length of transmission. If the turbines are located so that they take the steam from the ends of the distributing header, there probably will be no serious objection to the 12-in. pipe, but for a longer transmission, the 14-in. pipe may give better results.

R. E. T.

Effect of Reversal of Currents on Ammeter

KINDLY TELL me what the effect of reversing the flow of current through a direct-current ammeter would be. This has happened several times to an ammeter operating on a 220-v. circuit, and each time after this has occurred, the readings become more and more erroneous.

C. H. T.

A. In regard to running current in the reverse direction through a direct-current ammeter, this would certainly be likely to injure the meter. In the alternating-current ammeters, current may be run through in either direction, of course; but in the direct-current ammeters, the indication depends on the strength of a permanent magnet field, and if the current is reversed, it will throw the needle in the opposite direction.

This is liable to do 2 things—first, to bend the pointer, in which case your readings would come increasingly higher with each time that the machine was reversed; second, to injure the bearings, in which case the irregularity of indication might be in almost any direction; third, to change the magnetism of the permanent magnet, though this is unlikely, unless the current is very heavy in the reverse direction, and we would not expect more than a slight irregularity in reading from this third cause.

About all you can do is to send the ammeter back to the manufacturers for repair, unless the error is due to bending of the pointer, in which case you might remove the cover and bend the pointer so that it will stand at zero when there is no current. It is not wise to try to do anything with the mechanism of the meter, because this is so delicate, that unless one is entirely familiar with it and has the necessary tools to work with, he is likely to do more harm than good.

We have an idea, however, that the damage to the ammeter was done at the time the machine was reversed. Probably, at this time, there was an excessive current passed in one direction or the other, and this excess of current would be likely to do damage. It is not likely that the passage even of a considerable amount of current in the reverse direction through the ammeter would seriously injure it; but an amount largely in excess of the capacity of the instrument, even though it might be a kick for just an instant, would be likely to do damage, in the same way that any other quick shock would do to a delicate piece of apparatus.

A. L. R.

Reversing Engine Operation

WHAT WOULD BE the shortest possible time in which a twin reversing, direct-connected engine, of 46 by 60 in., 160 revolutions, could be reversed from full speed to full speed? The engine is connected to 2 sets of rolls of 31 in. diameter, in a rolling mill. C. A. H.

A. Reversing engines do not have balance wheels, but have their cranks set at 90 deg., in which position the engine is always in a position to take steam and run in either direction depending on the position of the reverse gear. And since they do not have wheels, the inertia of the moving parts is practically nil.

The valve gear is some form of positive drive, such as the slide valve or piston valve, or possibly with some form of adjustable cutoff, though this is seldom encountered. Shifting the reverse gear from one direction of rotation to the other is performed by some mechanical means, usually steam or air, the operator simply handling a small lever which in turn functions the valves controlling the reverse mechanism.

The reversing apparatus is similar in general shape to the familiar small simplex steam pump, only that the liquid end is constructed in such a manner that the liquid (usually oil) passes from one end of the cylinder to the other every time the reverse lever is operated, and the bypass arrangement is such that the speed of the reverse piston can be regulated so as to move fast or slow as the operator desires.

The reverse piston is adjusted to pass from one end of the cylinder to the other in the smallest space of time consistent with safety. Thus it is that the moment the billet is clear of the rolls, the operator throws the pilot, reverse follows after almost instantly, retarding only enough not to knock the heads out or something equally disastrous.

A good blooming engine operator has a peculiar knack of easing down on the throttle lever at just the proper moment so that when he throws the pilot reverse lever across, the reverse gear will shift the links (or other device) and the engine will instantly respond to the action of the steam and run in the other direction.

With a well designed engine, a sensitive reverse gear, and a quick and careful operator, an engine such as you describe could be reversed from full speed to full speed in 3 sec. or less. G. H. WALLACE.

Removal of Oil from Boilers

WHAT IS the best method of removing oil from the inside of a boiler where it is impossible to get at it, as between the tubes in a return tubular boiler?

2. Why have some Stirling boilers a corrugated support riveted to the heads of steam and water drums which rest on the I-beam, instead of allowing drum to rest in a cradle as it does on the opposite end? When the boilers are set in battery the outside ends of steam and water drum rest in the cradles, while inside ends with corrugated pieces riveted on the head rest on the I-beams. Why not have a cradle at each end?

M. P.

ANSWERS

THE BEST method of getting oil out of a boiler is to put in a strong solution of soda ash, filling the boiler clear full. Let this stand for 48 hr., and it would be a good proposition, if you can make such an arrangement, to connect the boiler feed pump so as to circulate this solution through the boiler, to give a washing effect at all points. Circulation should be as rapid as possible.

The amount of soda ash needed will depend upon the strength of the material which you are able to buy. The best way to test this out is to take a can having oil on the surface, and mix up a solution of the soda ash which you think will probably be right. Let it stand a while and see whether it tends to dissolve the oil. If it does not, increase the strength of the solution.

If the soda ash is not obtainable, you might use a strong solution of gold dust. Let it stand for 24 hr., then wash the boiler thoroughly, using as strong a stream of water as possible from a hose, and getting as direct a stream as possible on all parts.

2. As to the use of a corrugated support on Stirling boiler drums, we have never seen this method of suspension, but suppose it is used because of the unequal expansion of the steel suspension frame when the boilers are set in battery. Naturally, the frame between the 2 boilers will get hotter than that in the outside walls, hence it will tend to expand differently from the outside member of the frame. By putting in the corrugated support, it permits the expansion of these corrugations to take up part of this unequal expansion of the frame, and thus avoids straining the joints in the boiler structure itself. A. L. R.

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Tariff by Commission

Whether high or low, tariff is to be the policy of this country, either permanently or for a period, it would seem evident that the adjustment on different commodities should be based on facts. In the past, most of the evidence available has been submitted in connection with arguments of interested parties, and such investigation as was made was during the rush of framing a tariff bill and the heat of campaigning for and against given sections, with little regard for the effect on the business of the country as a whole. Real facts are not readily brought out by such a method.

Since 1909 a tariff commission has been urged by many statesmen regardless of party affiliation, and the sentiment has steadily grown that this is the reasonable way to get facts which will serve for the application of any policy that the country may desire put in force. The strength of this opinion is indicated by a recent referendum vote taken by the Chamber of Commerce of the United States in which 715 commercial organizations voted for the establishment of a permanent Tariff Commission, and only 9 voted against it. The commission proposed is to be nominated by the President and confirmed by the senate, independent of any Cabinet officer; not more than a majority is to belong to any one political party; permanency is secured by a 6 yr. term of office, efficiency by limiting to a small membership, say 5; and powers are to be clearly defined as collecting and systematizing facts without right to make any recommendations as to legislation unless requested to do so by one of the Houses of Congress.

Such a Commission would be unlike the temporary bodies that have heretofore existed to prepare or assist in preparing a special bill. It will have time and incentive to work carefully and scientifically, since its reports will have lasting effect on the business of the country. It will tend to secure fair treatment of all industries in all localities in the interests of the country as a whole, and thus promote the "fair deal." It will lessen the incentive to trading and dickering, and increase the opportunity for broad statesmanlike consideration of tariff questions.

Increase of commissions to regulate business is a policy of doubtful value, but a commission to secure facts needed for intelligent framing of legislation is along a different line. It is akin to a committee of a business corporation to investigate production costs, selling costs and methods and profits and report these to the directors for their guidance in determining the course of the business.

In line with this plan a Bill has been proposed by the Tariff Commission League for a Commission of 7 members for the purposes set forth, investigation of costs of production, effect of tariff, special investigations at the request of Congress, and reports to the President and Congress of facts ascertained. The Bill carries an appropriation of $300,000 a year for salaries and expenses. There may be difference of opinion as to details of the form of the Commission and desirable provisions of a Bill creating it, but the experience of

Congressmen in the past, the history of the framing of tariff legislation and the evident defects that have appeared in all such legislation, seem to make clear the desirability of and necessity for some form of impartial, permanent commission to relieve the situation of its worst features.

Fuel Waste in Ashes

Hardly a power plant in the country is not permitting from 5 to 15 per cent of the coal it uses to slip through its fingers, literally to slip through the grates, into the ash pile. A rain or a bucket of water thrown over the ash pile clearly shows up this waste. Still such sacrifice of good fuel is allowed to continue, partly because the presence of coal and small particles of coke are not readily apparent when cleaning out the ashpit and are therefore overlooked and partly because the seriousness of the loss is not fully realized.

Some loss of fuel in the ashes is unavoidable, the amount depending upon the size and quality of coal used and the size and condition of the grate bars, but this waste can be controlled to a considerable extent—in many plants could be cut in half or even in third. That this is not more commonly done is due to the fact that neither the extent of the waste is fully recognized, nor the fact that the equivalent coal loss due to the presence of combustible in the ashes follows a definite law which enables the actual monetary loss represented by any percentages of combustible in ash to be easily calculated.

Between the usual limits of 5 and 15 per cent of combustible in the ash, the resulting equivalent coal loss is about 30 per cent greater than the per cent of combustible in the ash; that is, for 7 per cent combustible in the ash there is an equivalent coal loss of slightly more than 9 per cent. This relationship between the combustible in the ash and the equivalent coal loss is somewhat less for lower proportions of coal or coke among the ashes and somewhat greater when the waste is more pronounced, but for all practical purposes the coal loss due to the presence of combustible in the ashes may be taken as 1.3 times the percentage of combustible present in the ash.

How serious this partially preventable loss may be is best illustrated by the consideration of a particular example. A 500-hp. plant operating 10 hr. a day on coal costing $4 a ton delivered to the furnace quite frequently may be so operated as to allow 10 per cent combustible to escape to the ash pile. This would amount to an annual loss of about $190, or about 13 per cent of the yearly expenditure for coal.

Under favorable conditions, the percentage of combustible in the ashes has, in certain plants, with due care been kept down to slightly over 1¼ per cent. This record is exceptional, however, and could not be equaled in many plants without entailing heavy expenditures in remodeling the grates, etc., but a record of 5 per cent should be attainable in almost any plant where conditions are not unusually poor. In the foregoing 500-hp. plant, this would mean a saving of about $100 a year.

Bettering the 5 per cent record necessitates highly efficient operation as well as well proportioned grates for the fuel employed and may be beyond the capabilities of most plants, unless a considerable expenditure is made to improve the boiler furnaces, etc. A 5 per cent record should be attainable in almost any plant, however, without any great expenditure. An average operation with 5 per cent combustible in the ash, instead of the present day average of 10 per cent of the valuable heat thrown away with the ashes, is possible and would represent a 6½ to 7 per cent reduction in the coal bills.

Anthracite vs. Bituminous for the House

From the records for 3 yr. past, it seems that production of anthracite coal has passed its maximum, as the output for 1913 was some 68,982,000 tons, for 1914, 68,342,600 tons and for 1915 is estimated at 66,382,000 tons. This is in part due to neglect of consumers of domestic sizes to lay in their supply in the early part of 1915, hence retailers have neglected to place orders; but mines have been operated at a rate higher than warranted by market conditions, so that mine storage yards are filled to capacity. Difficulty in supplying late winter demand may result, as car shortage makes it difficult to move the coal from storage yards to retailers, hence consumers would do well to be forehanded in placing orders for coal needed before summer.

Possibly some of the decreased domestic demand is due to greater use of bituminous coals for heating and cooking, the change over coming as a result of the higher prices for anthracite and better understanding of how to use the cheaper fuels satisfactorily. Makers of house-heating devices are studying the problem of bituminous burning continually, and are making good progress, so that it is to be expected that more and more the central and western sections will turn to the fuels of their own localities for domestic uses, thus avoiding the high freight costs which increase anthracite prices.

One large maker of boilers has practically perfected a gas-producer type of furnace for use with heating boilers, which operates as efficiently and with as little attention on bituminous coal as on anthracite, so that relief for the householder from anthracite domination seems in sight so far as heating is concerned. Stoves are still an unsolved problem, though the use of gas ranges in larger communities is becoming almost universal; while the disagreeable features of using bituminous coal in stores make it an important item to the user, the amount involved compared to the total coal output is not large, hence commercially it is a less important factor than heating by furnaces and boilers. And as the rate of combustion is usually higher than in a furnace and replenishing of fuel more frequent, the difficulty of proper burning is not so great. Probably briquets may be the answer to the problem from the standpoint of both economy and cleanliness.

Index for 1915

The index for Volume XIX of Practical Engineer is now prepared and will be sent free to subscribers upon request.

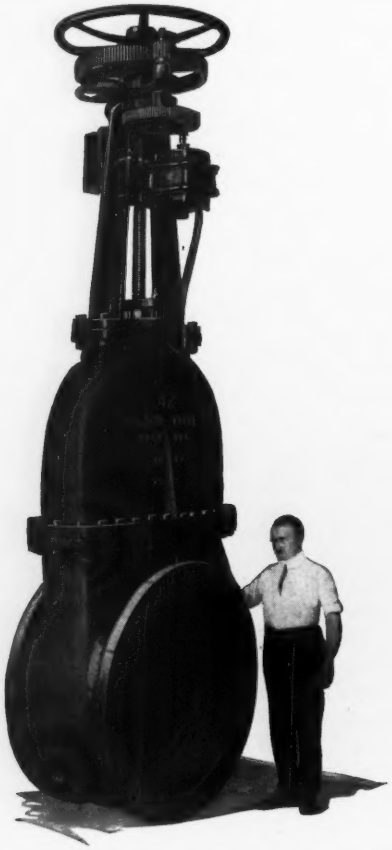
REPORTS OF PROXIMATE analyses and heat value of coals usually give the results calculated on at least 2 bases "as received" and "dry."

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Big Valves for Philadelphia Plant

THE Nelson Valve Co. has recently completed a portion of its contract for supplying the valves which are to be used throughout the new station of the Philadelphia Electric Co., of Philadelphia, Pa. Included in the installation will be valves of practically every kind, from the smallest brass gate and globe valves, to huge 42-in. solid wedge steel gate valves like that shown in the illustration.



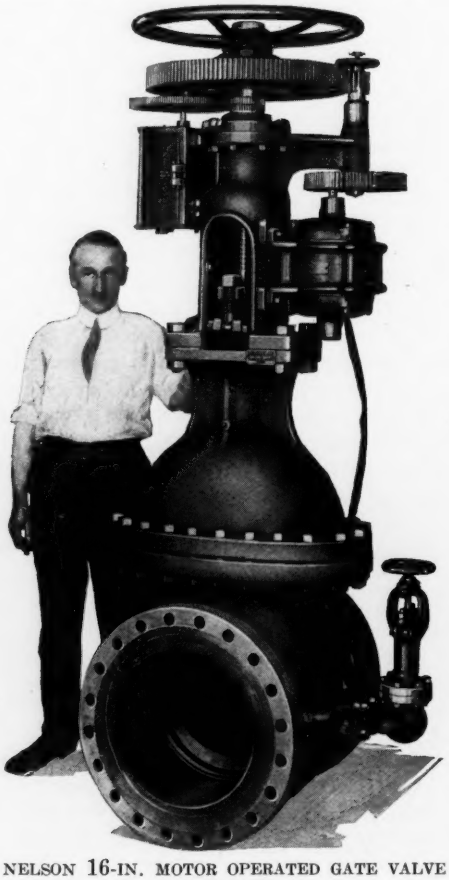
NELSON 42-IN. SOLID WEDGE GATE VALVE

These enormous valves stand 14 ft. high, and two of them weigh as much as an average size steam road roller. In all there are to be 7 of these monsters.

When installed they will be operated from central panels on the turbine operating floor, which is 50 ft. above the condenser pit floor line.

Operating conditions call for 80 lb. working pressure. The valves have a steel clutch for disengaging the motor, if it is desired to operate the valves by hand. The design is such, however, that hand operation drives the limit switch at all times, so that if the motor is thrown into operation when the valve is partly open, the limit switch is in the proper position for starting the motor, and throws out the automatic circuit breaker on the control panel at the proper closing point of the disc.

There is a lost motion device between the stem unit and the large operating gear, for the purpose of giving a hammer blow effect to break the seat of the valve, in the event of scale causing the wedge to adhere to the seat. The motor is designed, however, of ample torque to open the valve without this hammer blow effect.



NELSON 16-IN. MOTOR OPERATED GATE VALVE

The body, bonnet, yoke, yoke cap and glad are of cast steel. Cast monel seat rings have been used in the body, and the bonnet has a monel "pack-when-open" bushing. The solid wedge is cast in one piece of monel metal, and the rolled monel stem is attached to the wedge by means of a flexible coupling. The stem unit is of manganese bronze.

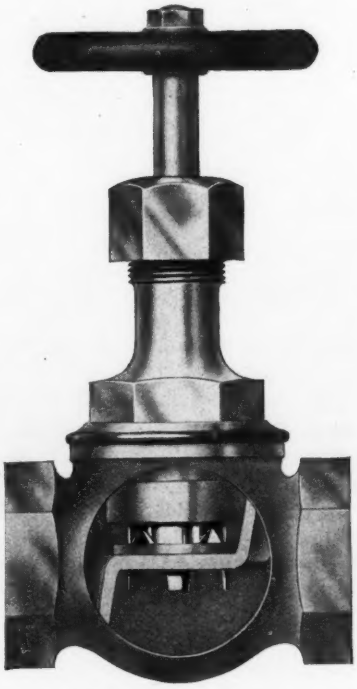
One characteristic feature of the valves is the high condensing chamber and deep stuffing-box, such as is used in Nelson valves for superheated steam service. The condensing chamber being located between the stuffing-box and the inside of the bonnet, insures longer life of packing and safety in renewing the packing.

In addition to the 42-in. valves, 7 16-in. gate valves have been built and sent to the Philadelphia Electric Co. These valves are made for superheated steam working pressure up to 250 lb., and for a total temperature of 800 deg. F. Each valve has been tested to 800 lb.

Throttling Nuts for Jenkins Bros. Valves

IT has long been a recognized fact that automatically operated pressure reducing or regulating valves should be provided with a special seat and disc in order to regulate properly the flow of fluids through them. Hand operated pressure regulating or throttling valves have seldom been provided with any special discs or seats for this purpose.

It would seem, however, that a special seat is as necessary in the latter as in the former valve, and it is



JENKINS BROS. VALVE FITTED WITH THROTTLING NUT

to supply this necessity that the throttling nut has been placed on the market. The valve body, seat and disc are of the standard Jenkins Bros. pattern, but the disc nut is made of such size as to effect a loose piston fit in the seat. It is also provided with projections as shown, which furnish the proper orifices to restrict the flow of the fluid so that the desired terminal pressure or the amount passing through the valve may be easily and accurately controlled.

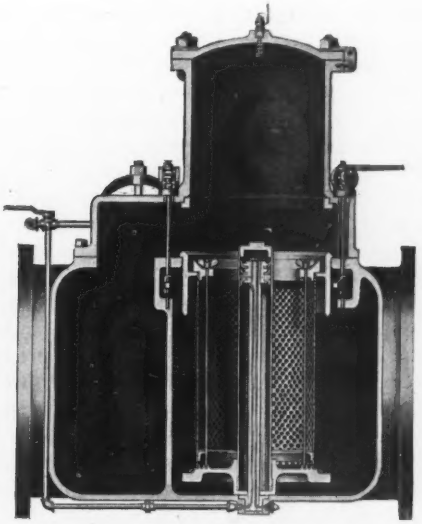
All the wear from the wire-drawing effect is taken up by this throttling nut and the side of the seat, and consequently the valve disc and the face of the seat will last much longer.

This valve will be found efficient as a throttling valve for the steam supply to a pump, heating kettle or similar device, and also where the flow of water to a tank, boiler, etc., is to be regulated.

These throttling nuts, which are suitable for Jenkins Bros. brass globe angle and cross valves, are manufactured by Jenkins Bros., New York.

Multiple Basket Strainer

SELF-CONTAINED water strainers of the removable straining basket type, are now well established as a necessary part of power plant and pumping station equipment for the protection of pumping engines, general service pumps and condensers from solid matter contained in the supply water. The strainer illustrated here is of this type, and is the standard design of strainer built by the Lagonda Mfg. Co., of Springfield, Ohio, with the exception of an improvement in design for automatic raising and lowering of the individual baskets for cleaning in place of the hand wheel and screw stem method. The hand wheel and screw stem design for raising the basket is thoroughly satisfactory; but for large sizes of strainers, where the baskets



SECTION THROUGH END BASKET OF LAGONDA HYDRAULICALLY OR COMPRESSED AIR OPERATED STRAINER

are large and heavy and the travel long, the manual operation is relatively slow and more or less laborious. In this new design the baskets are raised and lowered by air or water pressure, and the operation is almost instantaneous without exertion on the part of the operator.

Hydraulic or air operated strainer may be made up of several baskets, each basket being independent unit, with cleaning chamber valve and air or water control, so that each can be independently raised, removed and cleaned without interference with the operation of the remaining baskets.

The illustration is a section of the strainer through one basket, showing the construction and operation of the baskets and raising mechanism. The straining basket is rigidly supported on a circular base or disk which also serves as a valve seat when the basket is raised. Attached to the disk is a cylinder of small diameter, the whole moving freely up and down on a piston and piston rod, rigidly connected to the strainer body. The piston rod is provided with 2 conduits, communicating with the upper and lower sides of the piston and connected as shown through a 4-way control valve to the pump or compressor supply. The operation of raising or lowering a basket is then similar to the simple operation of an air brake.

Throwing the handle of the 4-way valve to one side, pressure is applied to the top side of the piston and the basket is raised to the cleaning chamber. The basket support or lower valve seat engages the sliding valve collar of the strainer, carrying it up with the basket to close completely the cleaning chamber or bonnet. The air or water pressure is sufficient to seal the valve water-tight; but for assurance against possible leakage or chance lowering of the disk while a basket is removed, there is supplied a cam lever locking device on either side of the strainer bonnets.

With the basket raised, the handle of this locking device is raised in a vertical position, then swung around until the projecting support is swung under the valve disk. The handle is then drawn down into the horizontal position. The cam draws the support tight up against the disk, insuring a tight fit and locking it in place. When the basket is raised, the top of the cylinder engages and raises the indicator rod in top of flange cap which shows the basket is in cleaning chamber. As soon as the basket is lowered, the spring pulls the indicator rod down, showing the basket is in straining position. In the flange cap a pet cock is provided for relieving any pressure in the cleaning chamber, so the hinged flange cap can be easily unbolted and opened for the quick removal of the basket. With the basket reinserted, the flange cap bolted down, the basket is lowered into position by releasing the locking device and throwing the handle of the 4-way control valve to the opposite side. The control valve is then thrown to the middle position, cutting off pressure from the basket cylinder when in the normal working position.

This design of automatically operated strainers is especially suited for power plants and large pumping stations, where the rapidity and ease with which the baskets can be removed and cleaned is essential.

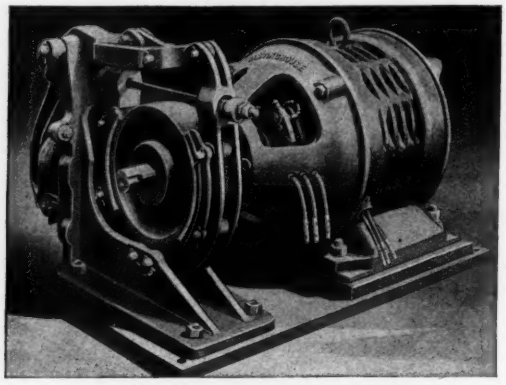
U. S. Civil Service Commission announces an examination for surveyor, on Feb. 2 and 3, 1916, to fill vacancies as they may occur in this position in the Engineering Department at Large, War Department, the usual salary being $90 to $150 a month, with subsistence when absent on duty from permanent station. Applications will be received from those who have graduated or are about to graduate in civil engineering from a recognized technical school, or from those who, in addition to a good general education, have had not less than 3 yr. of good general experience in surveying and leveling. Apply for Form 1312, stating the title, Surveyor (Male), to the U. S. Civil Service Commission.

New Magnetic Brake

MACHINE shop and mill operators will be interested in the new alternating-current magnetic brake described below. This brake has been designed especially for use with induction motors, operating cranes, hoists, roller-lift bridges, and many different classes of mill machinery, and it is applicable wherever frequent stops and reversals are necessary. The operating magnet is single-phase and may, therefore, be used on polyphase circuits.

The action of the brake is simple. When the controller is thrown to the off position, 2 brake shoes are forced by means of springs against a cast-iron brake wheel which is keyed to the motor shaft. When the motor is started, the magnet coil is energized and the action of the magnet, operating through a lever and a toggle, forces the shoes apart and releases the brake.

In the design of this brake, the Westinghouse Electric & Manufacturing Co. has embodied several improvements. It is a complete self-contained unit that can be mounted directly beside the motor or on a special



TYPE A BRAKE APPLIED TO POLYPHASE MOTOR MOUNTED ON SOLE PLATE

sole plate. Since the application of its braking action is not dependent upon gravity, it can be mounted in any position, from the horizontal to 90 deg., in such a direction that the movable magnet lever has no tendency to fall away from the stationary magnet core. This makes it especially desirable for applications where the position of the motor changes during operation, as on a roller lift-bridge. The overall height has been reduced to a minimum so that it can be used in places where head room is limited, as, for instance, in crane service. The insulation is such that the brake is adaptable for use outdoors and exposure to the weather without any modification whatever. No dashpots are used, thus all possibility of trouble due to sticking is eliminated. The brake shoes are made of cast iron to which are fastened woven asbestos fabric linings. The wheel is made of cast iron, and the coefficient of friction between the brake wheel and shoes is not materially affected by oil, grease or water.

The pressure on the brake shoes can be varied by means of nuts on the spring rods, and wear on the shoes can be taken up by means of an adjusting screw.

Two springs are used and only 2 adjustment points are necessary. If the operator fails to take care of the adjustment which compensates for wear on the shoes, the result will not be a failure of the brake to set; it will only mean that the machine cannot be started, as the brake will not release.

With a view to facilitating repairs, axle steel pins held in place by cotter pins have been used wherever possible. A pair of pliers and a screwdriver are the only tools necessary completely to dismantle or assemble the brake.

This brake, known as Type A, is made in sizes running from 5 to 100 hp. for 25 and 60 cycle, 220, 440 and 550 v. circuits.

Prize Contest for Articles

DIAMOND Power Specialty Co., which manufactures the Diamond soot blowers, has announced a contest for the 4 best articles submitted on the subject of Mechanical Soot Blowers.

This contest is open to all Consulting and Operating Engineers, and to Engineers-in-Charge, articles to be written on one of the following subjects:

What the Mechanical Soot Blower has done toward greater Economy and Efficiency in the Power Plant.

The Mechanical Soot Blower versus the Hand Method.

Why I Indorse the Use of Mechanical Soot Blower.

Why I have changed my Attitude in favor of Mechanical Soot Blowers.

Only one article will be accepted from each contestant, no article to be less than 1000 words in length, nor more than 5000. These articles must be written in ink or typewritten, on one side of an 8½ by 11-in. sheet, lettersheet size or about that, and must be in the hands of the Diamond Power Specialty Co., Detroit, Mich., on or before March 1, 1916.

The company reserves the right to use any of the manuscripts in any way it chooses, but will accept no article for competition unless proper entry is made before the article is submitted. The articles must be sent rolled or flat, not folded.

Prizes will be awarded as follows: $50 for the best article, $25 for the next best, $15 for the third, and $10 for the fourth—a total of $100, all to be awarded in gold, and the 4 prize winning articles to be published.

Entry may be made, or any inquiries in regard to the contest will be answered, by writing to the Prize Article Contest Department, Diamond Power Specialty Co., Detroit, Mich.

Better Business Conditions for 1916

THAT the outlook for better business for the first 4 months of 1916 is in striking contrast to that prevailing this time last year is the opinion expressed in a report just submitted by the Committee on Statistics and Standards of the Chamber of Commerce of the United States. There are localities where much caution and conservatism yet remain, and the influence of high prices for the future further accentuates this caution because dealers feel that high prices will curtail buying by the consumer. Broadly speaking, however, it may be said that the spirit of optimism and hopefulness prevails, and the general belief and expectation is for such prosperity during 1916 as will recompense the people of this country for past misfortunes.

Referring specifically to conditions caused by the European war, the report of this committee, of which A. W. Douglas of St. Louis is chairman, says:

"The adverse effect of the conflict in Europe still prevails in some sections, though to a much less extent than at this time last year. The large portion of the people are paying less and less attention to the war and more and more are concentrating their thoughts and efforts on domestic matters. Beyond this is the striking fact that the influence of the war at present as a whole is more favorable than adverse, because of the tremendous impetus it has given to certain lines of manufacturing, especially east of the Alleghanies, and likewise to many agricultural products. This influence is a material factor in the present high prices of sheep, cattle, wool, grain and of the products of leather, steel, iron, copper, brass, lead and zinc or spelter."

Railroads report better business as a whole and railroad shops are employing more and more men. Manufacturing has taken on new life through the whole country and in almost every branch. Abnormal activities prevail largely in the east and in certain portions of the central west because of heavy orders from abroad for war purposes, and this has created a temporary lack of raw material in many lines not otherwise affected by war orders. Prices are being advanced everywhere by manufacturers in all lines and they are continually being flooded with orders. Automobile factories and flour mills are exceedingly busy; likewise potteries, cement factories and furniture.

Merchandise stocks in the hands of the retailers vary from light to normal—the percentage being, by a small proportion, in favor of normal. Orders for future shipments in the spring are being more generally placed than for some years past, thus showing the confidence of the dealers in the immediate future.

Crop yields in general, other than cotton, exceed those of any year known in our history. This is especially true of the small grains as a whole, and particularly of all of the forage crops which are in abundance beyond precedent. This latter fact is one that is most significant and of very large moment to the country as a whole. It is of the utmost value and importance to the farmer to have cheap and abundant feed for his livestock through the winter, and this state of affairs at present exists as one of the stable foundations for that commercial prosperity which seems definitely to have arrived.

It seems now well settled that the cotton crop will be one of the smallest for several years; but it is being sold at remunerative prices, for it was one of the cheapest cotton crops ever raised because of economies of every kind and description enforced by necessity upon the farmers and planters. It is practically all picked, and a large portion of it is sold and the results of it are seen in the improved conditions in the cotton belt between now and twelve months ago.

Because of the unusual diversification in the south during 1915, there resulted the largest grain and forage

crops of all descriptions ever known in the history of that section. There are also more hogs, cattle and dairy cows in the south than ever before. The southern states as a whole are more self-contained than at any time in their history and are apparently on a sure and solid foundation in all agricultural and industrial ways. The optimistic spirit of the people as regards the future is shown in the great revival of business throughout that section, and the general opinion that the south has entered on a lasting period of prosperity.

There is more live stock in the country at this time than for the same time last year, despite the unfavorable conditions reported in certain sections in the northwest. The dairy industry continues to grow and expand in all sections of the country. Much the same is true of poultry products. Mining in all forms shows marked improvement of conditions prevailing a year ago.

Lumber business of the United States which has seemed dead for several years, according to the National Chamber report, appears only to have been sleeping. It is improving slowly throughout the entire country, due to increased orders for exports and to buying by railroads and car companies. It is expected that during the spring there will set in buying for homes, and a general revival of building throughout the country, especially outside of the large cities is looked for during the first six months of the coming year. Of all the so-called barometers of business, according to the authority quoted above, there are none so truly indicative of general prosperity as building. It is usually the last industry to feel the impulse of better times, but its activities embrace so many lines of business that this effect is general throughout the country.

James M. Dodge

JAMES MAPES DODGE, for years a leader in the development of apparatus for handling and storing coal and other bulk material, and Chairman of the Board of the Link Belt Co., died at his home in Philadelphia, Dec. 4, 1915.

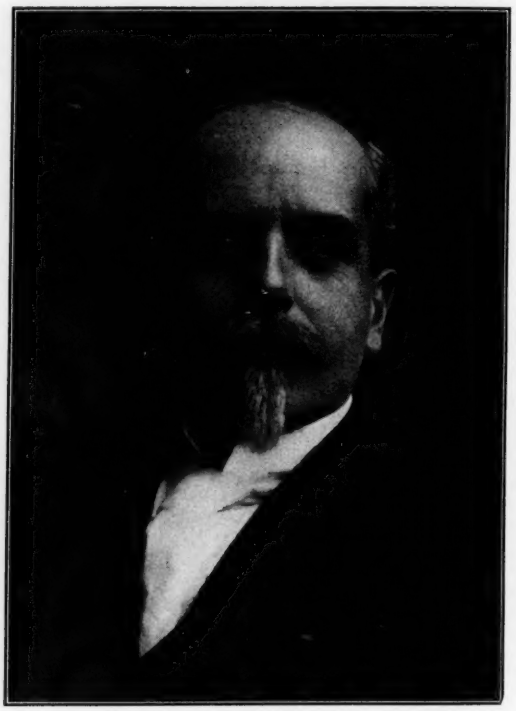
Mr. Dodge was born June 30, 1852, at Waverly, N. J., his grandfather being Prof. James J. Mapes, a noted chemist and scientist, and his mother, Mary Mapes Dodge, well known as author and editor of the St. Nicholas Magazine.

Following 3 yr. at Cornell University, and a year at Rutgers College, where he took a special course in chemistry, Mr. Dodge spent a time at the Morgan Iron Works, in New York City, then entered the shops of John Roach, shipbuilder, at Chester, Pa., where marked mechanical ability and ingenuity carried him in 3 yr. from journeyman to foreman, then to superintendent of erection.

Shortly after the Centennial at Philadelphia, in 1876, Mr. Dodge left the shipyard and was engaged in various work for several years, then going to Chicago where he met Wm. D. Ewart, inventor of the Ewart Link-Belting, with whom he soon joined hands to develop the chain business.

At that time, some 35 yr. ago, application of chains to power transmission was limited, and their use in elevating and conveying machinery practically unknown. Mr. Dodge and his associates were quick to seize the opportunity and adapt the Ewart chain to the new field, his work being principally development and manufacture, where his genius had full play to devise new chains, methods of manufacture and conveying and elevating appliances, which were brought out in rapid succession.

Following this development period, Mr. Dodge went East, entering into partnership with E. H. Burr as Burr & Dodge, who represented in Philadelphia the Ewart Mfg. Co. of Indianapolis, original manufacturers of the Ewart Detachable link belt. Out of this partnership grew the Link Belt Engineering Co., organized in 1888, in which Mr. Dodge carried his idea of development along strictly engineering lines, creating a highly specialized engineering staff, making scientific study of



the characteristics of materials to be handled, and inventing special appliances to meet varying conditions. Capacities of machines increased from 30 tons an hour to 1000 tons an hour, and problems from simple use of detached machines, to planning and arranging works for the most economical and efficient handling of raw and finished product, under guarantees of accomplishment.

In 1889, having thoroughly studied the needs of the anthracite coal industry, Mr. Dodge developed the boldest, and perhaps the most original of his inventions, namely, his system of storing coal in large conical piles and reloading it by machinery with little labor and practically no breakage. This invention was so complete, and yet so simple, that it is still without rival as a method of storing anthracite coal. For this, in 1907, he was awarded the Elliott Cresson Gold Medal, by the Franklin Institute of Philadelphia, a medal which has been received by such men as Thomas A. Edison. The Dodge system of coal storage reduced the cost of hand-

ling, in and out, from 30 to 40 cents a ton round trip, to less than 5 cents, from which the saving effected on the 5,000,000 tons handled annually by this system is evident.

Fertility of invention and mechanical ingenuity, coupled with rare executive ability, brought success to Mr. Dodge, who had the distinction of being among the few who had been granted over 100 letters patent, and as an executive, won success as President and active managing spirit of such highly successful industrial engineering corporations as the Link-Belt Engineering Co. and the Dodge Coal Storage Co. (later called the J. M. Dodge Co.) He was elected President of these companies in 1892, and Chairman of the Board of Directors of the Link-Belt Co. when, through merger of the Link-Belt Engineering Co., of Philadelphia, the Link-Belt Machinery Co., of Chicago, and the Ewart Mfg. Co., of Indianapolis, this company was created in 1906. At that time, Charles Piez became President of the Link-Belt Co. Mr. Dodge was responsible for the design of links and attachments in all the various sizes of link belting used today, and owing to the excellence of his original designs, practically no improvements have been made.

Among his important inventions, were those relating to construction and manufacture of silent chain, the bushed joint applied to this type of power transmitting medium again proving his ingenuity and furnishing a long desired product which has received constantly increasing recognition.

Though for many years a large employer of men, Mr. Dodge never encountered strikes or other labor difficulties, and was deeply interested in the personal welfare and advancement of his associates, as well as a conspicuous leader in the general introduction of the best elements in scientific management. He had the double purpose of producing greater efficiency in the mechanical and human factors, and securing better pay, with shorter hours, and improved conditions for the men.

For many years he was closely associated with the late Dr. F. W. Taylor, in a wide circle of industries, accomplishing remarkable results for the benefit of both employers and employes, his influence being always toward the development of self-help, initiative, ambition and responsibility in the men, and a spirit of fair play as a real business asset in the employers who recognized his leadership in modern progressive methods.

He was always affirmative in his views, fertile in suggestions, and quick to point out the way for betterment or improvement rather than to condemn or discountenance. He was encouraging, optimistic, and a constant inspiration to those with whom he came in contact, always a leader in various societies and clubs of which he was a member, public spirited and willing to do more than his share for their advancement. His membership included the American Society of Mechanical Engineers, of which he was a Past President; Franklin Institute, of which he was Vice President; Philadelphia School of Design, of which he was a Trustee; the Union League Club of Philadelphia, University Club and Zeta Psi Fraternity. In recognition of his accomplishments, he received the Honorary Degree of Sc. D. from Stevens Institute of Technology.

Mr. Dodge was in the prime of life, and the news of his decease comes as a shock to the large circle of friends who have been cheered and helped by knowing him, and who have looked forward to many years of pleasant meetings with Mr. Dodge, and of well-earned enjoyment for him in the work which he delighted to do.

Geo. D. Rollins

GEO. D. Rollins, for several years General Manager of the Holmes Metallic Packing Co., of Wilkes-Barre, Pa., who died at the Samaritan Hospital in Philadelphia, on Dec. 16, was born in West Townsend, Vt., Aug. 6, 1836. He attended the Public Schools until his 14th year, when he started to learn the machinist trade, which he followed until the Civil War broke out, thereupon going to work for the U. S. Government in the Government Armory at Springfield, Mass. Later on, he was associated with the Smith & Wesson Revolver Factory for a number of years, after which he entered the machinery and supply business. In 1901, he became associated with the Holmes Metallic Packing Co., in which he held a large interest, and took out a number of valuable patents on Metallic Packing and other specialties during his connection with the company.

Mr. Rollins was a member of the various Masonic bodies in Massachusetts, being a Knight Templar and 32nd Degree Mason; also a member of the Odd Fellows Lodge, Red Men and Travelers' Protective Association, being the organizer of Post A of Philadelphia. He is survived by his widow, one daughter and one son, Fred G. Rollins, who is president and principal holder in the Holmes Metallic Packing Co.

INSURANCE OF POWER plants against fire, according to the Standard Handbook for Electrical Engineers, varies from less than 0.1 per cent for fire proof modern plants to as high as 1 per cent for the old type of plant with oil soaked wooden floors, etc. Insurance in a modern plant may seem unnecessary, but the regular visits of insurance inspectors have a beneficial influence on the operation of the plant which is frequently worth more than the cost of the insurance. The figure commonly used for the cost of insurance is 0.5 per cent.

Research Fellowships in the Illinois Experiment Station

SINCE 1907, 10 Research Fellowships have been maintained in the Illinois Experiment Station in the University of Illinois, to strengthen the field of graduate work and assist in enlargement of engineering knowledge. Each of these pays an annual stipend of $500, and is open to graduates of approved American and foreign universities and technical schools. Appointments to these fellowships are made and must be accepted for 2 consecutive collegiate years, at the expiration of which time, if all requirements have been met, a Master's degree will be granted. Not more than half the time of the men holding Research Fellowships is required in connection with the work of the department to which they are assigned, the remainder of their time being available for graduate study.

Nominations to Research Fellowships, accompanied by assignments to departments of the Station, are made, from applications received by Director W. F. M. Goss of the Station not later than Feb. 1 of each year. These nominations are made within the month of February by the Station Staff, subject to the approval of the Faculty of the Graduate School and the President of the University, and appointments are made in March to take effect the first day of the following September.

These nominations are based upon character, scholastic attainments, and promise of success in the principal line of study or research which the candidate desires to follow, preference being given to applicants who have had some practical engineering experience following their undergraduate work.

The Engineering Experiment Station, established in 1903, is an organization within the College of Engineering, for the purpose of carrying on investigations in various branches of engineering, and to study problems of importance to engineers and to manufacturing and industrial interests of the state. Work may be undertaken in architecture or architectural engineering, chemistry, civil, electrical or mechanical engineering, mining, municipal or sanitary engineering, physics, railway engineering, and in theoretical and applied mechanics.

Heads of departments in the college constitute the administrative station staff, investigations being carried on by members of the staff and other members of the instructional force of the College of Engineering, by special investigators employed by the Station, and by the Research Fellows.

By action of the Board of Trustees, in March, 1915, 4 additional Research Fellowships were created, making 14 in all now available.

Applications may be filed, or additional information obtained by addressing the Director, Engineering Experiment Station, University of Illinois, Urbana, Ill.

THERE ARE 2 classes of errors in any kind of measurements—systematic and accidental. The former class affects each result in a series of similar observations, as an error in the standard used. The latter class includes those over which the observer has no control and are usually those due to observation.

News Notes

PAUL M. LINCOLN, whose connection with the Westinghouse Companies in their operating and engineering activities dates back for over 23 yr., as of Jan. 1, 1916, becomes associated with the sales organization of the Westinghouse Electric & Mfg. Co. with the title of Commercial Engineer.

Mr. Lincoln is well known in engineering circles through his active work in the American Institute of Electrical Engineers, of which he is a past president.

He is a well known writer on technical subjects and has also been identified with educational work for some time, filling the chair of professor of electrical engineering of the University of Pittsburgh.

Mr. Lincoln was graduated from the Ohio State University in 1892.

THE COLLEGE OF ENGINEERING of the University of Illinois is to receive from the Commonwealth Edison Co., of Chicago, Ill., through the courtesy of its president, Samuel Insull, as a museum exhibit a vertical triple-expansion engine with its direct-connected generators and their equipment of transformers, regulators, switches, instruments, etc.

Mr. Insull's letter of presentation sets forth the fact that this engine, which was one of 10 similar units, has a normal rating of 600 hp. and was built in the year 1893, by the Southwark Foundry & Machine Co., of Philadelphia, Pa. It was erected during the winter of 1893-94 in the power house of the then Chicago Edison Co.

Direct-connected to the engine, one on each side, were 2 200-kw. 150-v. direct-current generators, built by the General Electric Co. The Chicago Edison Co. later replaced these generators with the present double-current machines which were among the first of this type of generators built. The unit was put into service on Aug. 1, 1894.

The large size and efficiency of its generating units (as these units were at that time regarded) made the Harrison St. Station celebrated for the character of its

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

FUEL AND HEAT LOSSES BETWEEN MINE AND CRANK SHAFT

FROM FACTORY

Stage	Character or Cause of Loss	(1) Preventable	(2) Non-preventable	(3) Total Plus (2)	Net B. T. U.	Per Cent
	Theoretical Heat Units B. T. U. in Original Ton of Coal				29,000,000	100
Mine to Furnace	Handling and Weathering	290,000	290,000	580,000		
Furnace	Uncommuned Coal in Ash	1,126,800	294,200	1,421,000		
	Radiation from Furnace	852,600	284,200	1,136,800		
	Chimney Loss to Maintain Draft	204,308				
	Air Leakage Due to Bad Settings	2,842,000	3,410,400	3,615,308		
	Air Leakage Due to Poor Firing	2,842,000		5,684,000		
	Moisture in Coal and in Air		426,300	426,300		
	Total Furnace Losses	8,168,308	4,695,100	12,863,408		
				Delivered to Boiler	16,136,592	55.7
Boiler	Unabsorbable Heat in Flue Gases	1,280,907		1,280,907		
	Soot on Outside Boiler Tubes	1,126,561		1,126,561		
	Scale on Inside Boiler Tubes	1,452,283		1,452,283		
	Slack Coal Losses	1,116,800		1,116,800		
	Improper Draft Regulation	1,116,800		1,116,800		
	Total Boiler Losses	4,018,395	1,280,907	6,390,293		
				Converted into Steam	10,587,302	87.4
Pipes	Leakage of Water and Steam	216,685		216,685		
	Friction and Radiation	568,742	216,685	1,746,427		
	Total Pipe Losses	1,988,127	216,685	1,963,112		
				Delivered to Engine	9,597,190	82.9
Engine	Exhaust	7,627,331		7,627,331		
	Condensation and Radiation	119,177		119,177		
	Friction in Engine	1,850,468		1,850,468		
	Total Engine Losses	7,746,508		9,597,190		
				Converted into Power	1,014,000	3.5
Total	Grand Total Losses	13,989,200	27,986,574			
	Per Cent	48.5%	96.5%			
		14,046,774				
		48.5%				

PRACTICAL ENGINEER

FRICTION OF WATER IN IRON PIPES

PRACTICAL ENGINEER

CONVEYOR BELT CALCULATING CHART

WIDTH OF BELT - INCHES
NUMBER OF PLIES
L = LENGTH FACTOR
L = (L + 10H)
L = LENGTH OF BELT
H = DIFFERENCE IN ELEVATION BETWEEN HEAD AND TAIL ENDS

For selecting the correct number of plies, where belts operate under specific conditions.

Explanation: Start from the width on the scale at the left, move to the right until the proper length factor line is intersected, then either up or down until the line corresponding to the material handled is intersected, then to the right again where the next largest number on the scale will indicate the correct number of plies. If driving pulley is rubber lagged, multiply number plies by 0.84 or 5/6; if tandem drive, bare pulleys by 0.67 or 2/3; if tandem drive, lagged pulleys by 0.55 or 11/20.

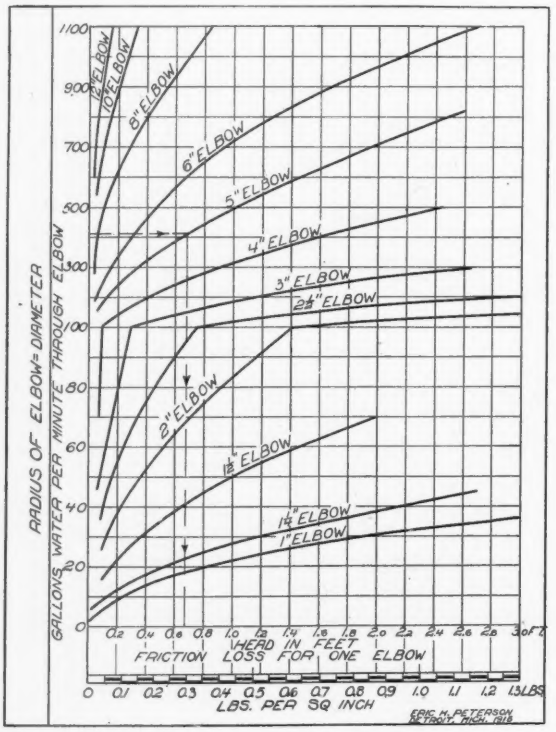
THE B. F. GOODRICH CO.

PRACTICAL ENGINEER

MANILA ROPE AND COMMON KNOTS

Diam. In.	Weight per Coil lb. (1200 ft.)	Length per lb.	Working Load Safety Factor 7 Single Block	Double Block	Quadruple Block	Knots Number	Name	Efficiency & to Safe Load	Factor of Safety to Safe Load.
3/16	36	50 feet	33	66	132	14-12	Eye Splice	90	6.5
1/4	45	40 "	57	114	228	3	Timberhitch		
5/16	50	30 "	90	180	360	4	Fisherman's		
3/8	66	24 "	129	258	516	5	Rd turn & 1/2	65	4.5
7/16	66	20 "	177	354	710	6	Well Knot Hitch		
1/2	85	16 "	231	462	924	7 & 8	" Crown		
9/16	100	14 "	293	586	1172	9	Right		
5/8	120	12 "	322	644	1644	10	Overhand		
11/16	140	10 "	411	822	1644	11	Figure 8		
3/4	160	9 "	645	1290	2580	12	Bowline		
13/16	200	8 "	777	1554	3108	13	Chain		
7/8	240	7 "	925	1850	3700	14	Fisherman		
15/16	280	6 "	1085	2170	4340	15	Slip	45	3.1
1-1	320	5 "	1260	2520	5040	16	Square	50	3.5
1-1/16	360	4-1/2 "	1445	2890	5780	17	Weaver's	50	3.5
1-1/8	400	4 "	1640	3280	6560	18	Sheet	45	3.1
1-3/16	440	3-1/2 "	1857	3714	7428	19	Bowline		
1-1/4	480	3 "	2086	4170	8340	20 - 22	Stevedore	60	4.2
1-5/16	520	2-9/10 "	2311	4622	9244	23 - 24	Garrick		
1-3/8	560	2-7/8 "	2571	5142	10284	25	Timber Hitch	65	4.5
1-7/16	600	2-5/8 "	2857	5714	11428	26	Clove "		
1-1/2	640	2-1/2 "	3168	6336	12672	27	Rolling "	65	4.5
1-5/8	720	2-3/8 "	3511	7022	14044	28	Timber & 1/2 Hitch		
1-3/4	800	2-1/4 "	3887	7774	15548	29			
1-7/8	880	2-1/8 "	4345	8690	17380	30			
2	960	2 "	4843	9686	19372				
2-1/8	1040	1-9/10 "	5043	10086	20172				
2-1/4	1120	1-7/8 "	5705	11410	22820				
2-3/8	1200	1-5/8 "	6570	13170	26340				
2-1/2	1280	1-1/2 "	7457	14914	29828				
2-5/8	1360	1-3/8 "	8328	16656	33312				
2-7/8	1440	1-1/4 "							
3-	1520	1-1/8 "							

FRICTION OF WATER IN 90 DEG. ELBOWS

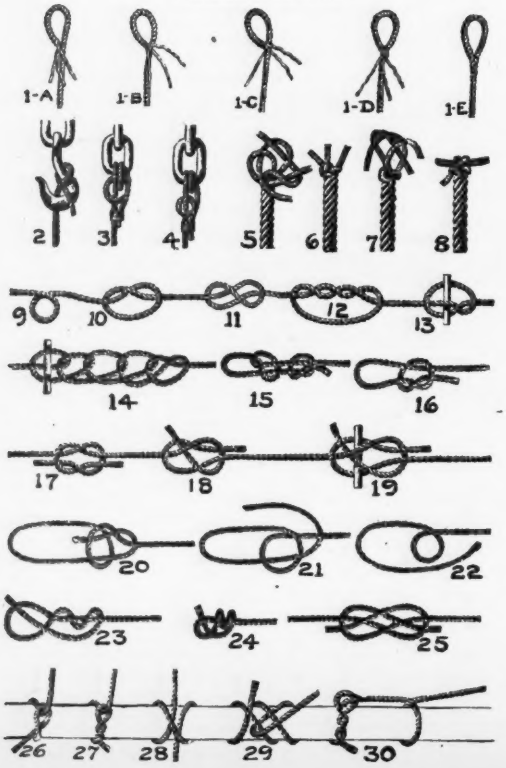


BOILER EFFICIENCY TABLE, BASED ON EVAPORATION FROM AND AT 212 DEG. F.

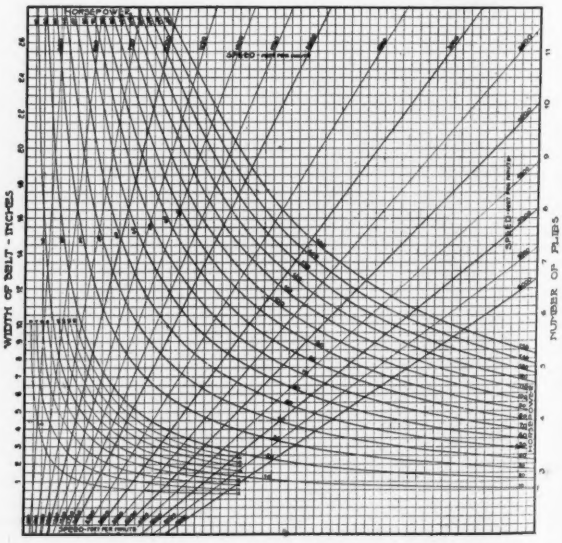
EFFICIENCY		50%		55%		60%		65%		70%		75%		80%	
B. T. U. Per lb. Coal		Evaporation Per lb. Coal	Lbs. Coal Per H. P. Hour	Evaporation Per lb. Coal	Lbs. Coal Per H. P. Hour	Evaporation Per lb. Coal	Lbs. Coal Per H. P. Hour	Evaporation Per lb. Coal	Lbs. Coal Per H. P. Hour	Evaporation Per lb. Coal	Lbs. Coal Per H. P. Hour	Evaporation Per lb. Coal	Lbs. Coal Per H. P. Hour	Evaporation Per lb. Coal	Lbs. Coal Per H. P. Hour
7,500		3.8	9.0	4.2	8.2	4.6	7.5	5.0	6.8	5.4	6.4	5.8	6.0	6.2	5.5
8,000		4.1	8.4	4.5	7.6	4.9	7.0	5.3	6.5	5.7	6.0	6.2	5.5	6.6	5.2
8,500		4.4	7.9	4.8	7.1	5.2	6.5	5.6	6.1	6.0	5.6	6.5	5.2	7.0	4.9
9,000		4.6	7.5	5.1	6.8	5.5	6.2	5.9	5.8	6.3	5.3	6.9	4.9	7.4	4.6
9,500		4.9	7.0	5.4	6.3	5.9	5.8	6.3	5.4	6.8	5.0	7.3	4.7	7.8	4.4
10,000		5.1	6.7	5.6	6.1	6.2	5.5	6.7	5.1	7.2	4.7	7.7	4.4	8.2	4.2
10,500		5.4	6.3	5.9	5.8	6.5	5.3	7.1	4.8	7.6	4.5	8.1	4.2	8.6	4.0
11,000		5.6	6.1	6.2	5.5	6.8	5.0	7.4	4.6	7.9	4.3	8.5	4.0	9.1	3.7
11,500		5.9	5.8	6.5	5.3	7.1	4.8	7.7	4.4	8.3	4.1	8.9	3.8	9.5	3.6
12,000		6.2	5.5	6.8	5.0	7.4	4.6	8.0	4.3	8.6	4.0	9.3	3.7	9.9	3.4
12,500		6.4	5.3	7.1	4.8	7.7	4.4	8.4	4.1	9.0	3.8	9.7	3.5	10.3	3.3
13,000		6.7	5.1	7.4	4.6	8.0	4.3	8.7	3.9	9.4	3.6	10.0	3.4	10.7	3.2
13,500		6.9	4.9	7.6	4.5	8.3	4.1	9.0	3.8	9.7	3.5	10.4	3.3	11.1	3.1
14,000		7.2	4.7	7.9	4.3	8.6	4.0	9.4	3.6	10.1	3.3	10.8	3.1	11.5	3.0
14,500		7.5	4.6	8.2	4.2	9.0	3.8	9.7	3.5	10.5	3.2	11.2	3.0	12.0	2.8

BLAISDELL CANADY CO.

COMMON KNOTS



TRANSMISSION BELT CALCULATING CHART



For selecting the correct number of plies, where belts operate under specific conditions.

Explanation: Sart from the width on the scale at the left, move to the right until the proper (curved) horsepower line is intersected, then either up or down until the line corresponding to the speed is intersected, then again to the right where the next larger number on the scale will indicate the correct number of plies.

THE B. F. GOODRICH CO.

equipment and for its great aggregation of power; but so rapid has been the increase in the size and efficiency of steam prime movers, accentuated in recent years by the advent of the steam turbine, that within 10 yr. from the time that these engines were put into service they passed out of use because they were considered small, inefficient and inadequate.

The engine described will constitute an historical exhibit of high value. Its advent upon the Campus will aid in accentuating a purpose, frequently expressed by the Trustees of the University, to develop an industrial museum, in which shall be preserved such machines and mechanical devices as will serve to disclose to future generations something of the significant work that has been accomplished by those of our time. Once securely established such a museum will year by year for an indefinite period draw to itself added materials representative of its time.

U. S. CIVIL SERVICE COMMISSION announces an examination for physical laboratorian, on Feb. 2, 1916, to fill a vacancy at $3.84 a day at the Naval Proving Ground, Indian Head, Maryland. Applicants should possess at least the equivalent of a high school education in mathematics; should be able to use logarithms with facility, solve practical problems in plane trigonometry, and to plot the graphs of plane curves. Age, 20 yr. or over; photographs required. Apply for Form 1312, stating the title, Physical Laboratorian (Male).

Catalog Notes

THERE HAS just been issued by the Bureau of Standards, of the Department of Commerce, a paper dealing with the factors which influence the resistivity of the soil and with the effects of soil resistance on the leakage of currents from street railway lines using the rails as return conductors. Three methods of determining the specific resistance of soil are given and the results of a large number of measurements are tabulated.

The principal factors which influence soil resistance are described and their effects on the results of electrolysis surveys and on the escape of currents from street railway tracks are discussed.

Copies of the publication, Technologic Paper No. 26, entitled "Earth Resistance and Its Relation to the Electrolysis of Underground Structures," may be obtained free of charge upon application to the Bureau of Standards, Washington, D. C.

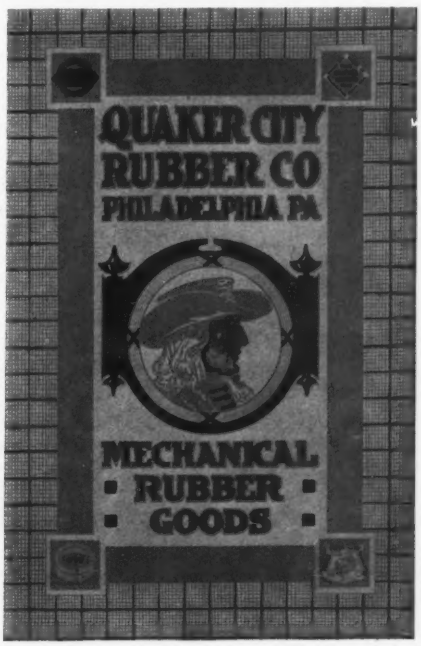
JUST OFF THE PRESSES is a new 31-page illustrated catalog describing in detail the working of the Ohio Blower Co.'s Swartwout steam specialties and including detailed specifications and list prices of all the articles in this line, which includes exhaust heads, oil separators and steam separators.

Among the interesting features which make the book attractive are a foreword on the principle of a helico-centrifugal apparatus, accounts of tests of Swartwout steam separators made by Professor C. H. Benjamin, in the engine room of Case School of Applied Science, and by F. W. Ballard, M. S., Commissioner of Light, Heat and Power for the City of Cleveland, and photographs, diagrams and specifications of all types of these separators (vertical and horizontal) and of flanges.

The information regarding each type includes such data as size of pipe, principal dimensions, body of flange, net weight, gross weight and cubic contents of package ready for shipment, number and diameter of bolts, and complete price tables.

The careful enginer who recognizes the value and importance of dry steam will find much in these pages to interest him, together with reliable and complete data from which to determine his steam specialty needs. A handsome cover in 3 colors gives a foretaste of the care with which this catalog has been compiled. A copy can be obtained by a request addressed to the Ohio Blower Co., Cleveland, Ohio.

QUAKER CITY RUBBER CO., of Philadelphia, Pa., issues a beautiful catalog of mechanical rubber goods, of which the cover is reproduced herewith. It deals with rubber belting, hose, packings and other mechanical rubber devices of all descriptions, such as valves, gaskets, diaphragms, rings and washers, mats, buffers, gloves, etc. A full description of each article is given with illustration and price list, and an interesting discussion of the properties of belting for different uses, of the construction and proper methods of lacing of rubber belts, horsepower of belting, and the proper construction of hose for different purposes is included.



It is an exceptionally fine job of the printer's art, in 2 colors, on a heavy coated paper, containing 180 pages, and with heavy flexible binding.

THE 1916 ILLUSTRATED calendar of Samuel Smith & Son Co., Paterson, N. J., was recently received.

THE ASHTON VALVE CO.'S 1916 calendar in colors has just been received, copies of which can be obtained by sending 10 cents in stamps to the company at 271 Franklin St., Boston, Mass.

Trade Notes

NATIONAL REGULATOR CO., with general offices at 208-212 S. Jefferson St., Chicago, announces that it has organized a Sales and Repair Department and will give immediate attention to estimates on overhauling, for the replacement of new material, and for any other maintenance and repair service.

YEOMANS BROTHERS CO., 231 Institute Place, Chicago, announces that by a special agreement entered into with the Shone Co., of Chicago, Yeomans Brothers Co. has taken charge of the sale and installation of the Shone pneumatic sewage ejectors throughout the United States and Canada, and now offers for sale from this office and through established agencies and those of the Shone Co., the Shone ejector in addition to its usual line of pumping machinery.

THE PRIZE Article Contest which is now being conducted by the Diamond Power Specialty Co., of Detroit, and in which $100 in gold has been offered for the 4 best articles on the subjects of Mechanical Soot Blowing, is attracting engineers in all parts of the United States and Canada.

Although the contest, which is open only to consulting and operating engineers, and to engineers-in-charge, does not close until March 1, a number of articles have already been received. Full particulars may be had by addressing the Prize Article Division, Diamond Power Specialty Co., Detroit, Michigan.

HOMESTEAD VALVE MFG. CO., of Pittsburgh, Pa., has been appointed eastern representative of the Taylor Steam Specialty Co., of Battle Creek, Mich., and will handle its specialties in all territory east of the Ohio River. The line consists of the return trap, separating or non-return trap, vacuum trap, siphon heat circulator and cast-iron exhaust head.

Homestead Valve Mfg. Co.'s Engineering Department will be glad to give advice and engineering service in regard to the return of condensation to boilers by the use of return traps, or to lay out and superintend the installation of exhaust steam systems for heating factory buildings, drying rooms, etc. John T. Bealor will be in charge of the department.

GOODYEAR TIRE & RUBBER CO. held its annual meeting at Akron, O., Saturday, Dec. 4, and reports represented show that the year 1915 has been the most profitable in the history of the company. G. M. Stadelman, who has been secretary of the company and also acted as sales manager, was made a vice-president and continued in his position as sales manager. P. W. Litchfield, who has been factory manager, was continued in charge of factory operations, and elected vice-president, and A. F. Osterloh was promoted from the position of assitant secretary to the secretary's office continuing also as assistant sales manager. C. W. Seiberling was re-elected vice-president. Other officers chosen were: F. A. Seiberling, president; F. H. Adams, treasurer; W. E. Palmer, assistant secretary and assistant treasurer; H. J. Blackburn, second assistant treasurer.

Reports show an actual growth in business of 17 per cent for the year 1915, and a probability of 50 per cent increase during the next year was indicated, factory additions of more than 11 acres now being under construction to make room for increased working force.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

SEMI-MONTHLY

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.
In Canada, subscription price, $1.75 a year.
Foreign Countries, subscription price, $2.50 a year.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 So. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

ADVERTISING RATES

Display

Full page, one year, each insertion, $60.00.
Half page, one year, each insertion, $35.00.
Quarter page, one year, each insertion, $20.00.
Eighth page, one year, each insertion, $12.00.
Front cover, $150.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

Classified Rates

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—As engineer. Have had 16 yr. practical experience in operating Electric Light and Refrigerating power plants efficiently and economically. Capable of making all repairs. Address Practical Engineer, Box 415, Chicago, Ill. 1-15-1

POSITION WANTED—Young man wants position as helper and extra engineer in steam plant for a start. Other particulars answered by letter. Write W. D. Bellesfield, Rock Valley, Iowa. 1-16-1

POSITION WANTED—By man with 18 yr. practical experience—4 yr. in general repair shop and 14 yr. in running engines. Have had considerable experience with Electric Light Plants, Flour Mills, as night Superintendent of Water Works, and Engineer in Oil Mill. I prefer night work (compressors) in Oil Mill if steady work. 36 yr. old. Married. Sober and steady worker. References. At present employed but desires change. Address Practical Engineer, Box 416, Chicago, Ill. 1-15-1

POSITION WANTED—By man who has made steam engineering a life study; have had several years' experience; at present am student in Complete Steam Engineering course with I. C. S. Would like position as engineer, assistant or oiler, with reasonable salary to start, and where I can advance according to merits. Age 26. Address Practical Engineer, Box 419, Chicago, Ill. 1-15-1

POSITION WANTED—Chief engineer, now employed, wants change. With present company 10 years. Understands ammonia refrigeration, air compressors, pumps, etc. All electrical repairs—A.C. and D.C., phone wiring, etc. 72 per cent boiler efficiency last year. 35 years old. American. What have you to offer? Address Box 415, Practical Engineer, Chicago, Ill. 1-15-1

POSITION WANTED—By a young man, experienced operating engineer in both steam and electricity, as manager of light plant in a town of from 2,000 to 5,000. Can show a good record as an organizer. Full qualifications and references upon request. Address Box 374H. Practical Engineer, Chicago, Ill. 12-15-3

POSITION WANTED—Manager, experienced in brass sheet, tube, wire and stamped and screw machine products manufacture, ready for prompt engagement. Technical and sales ability. Full references available to proper parties. Age 31. Address Yankee, care Practical Engineer, Chicago, Ill. 1-15-1

POSITION WANTED—As Chief engineer. Have had extensive experience in operating, overhauling and erecting ice making, packing house and cold storage plants. Efficient and economical. Best results assured. Address Practical Engineer, Box 417, Chicago, Ill. 1-15-1

POSITION WANTED—By operating engineer, age 30, 6 yr. experience with Corliss and high speed engines, direct-current generators and motors, and gas engines, operating from automatic suction gas producers. Best of references. Address F. J. Forboul, Beaver Dam, Wis. 1-1-2

POSITION WANTED—Chief Electrician. Young man having had long experience in installing, maintaining and repairing in A.C. and D.C. plants, desires to take charge where improvements in motor operation will be welcomed. Address Practical Engineer, Box 409, Chicago, Ill. 1-15-1

POSITION WANTED—As advanced sales prospect man with firm manufacturing or selling power plant machinery, by thoroughly practical engineer with several years' traveling experience. Can furnish my own auto if desired. Address Practical Engineer, Box 412, Chicago, Ill.

POSITION WANTED—As operating engineer; perfectly at home in either electric lighting or ice plants; 15 years' continuous experience. Married, sober and reliable man. Address E. S. C., care Practical Engineer, Chicago, Ill. 1-15-1

Help Wanted

WANTED, STATIONARY ENGINEER—The Illinois State Civil Service Commission will hold an examination for this position at Chicago, Kankakee and Lincoln on February 5, 1915. Salary $75 to $100 a month. Open to men over 25 years residing in Cook, Kankakee, Iroquois, Logan and DeWitt counties. For details and applications, address State Civil Service Commission at Springfield, Ill., or 904, 130 North Fifth Ave., Chicago.

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

FREE ENGINEER BOOKS and power plant tool and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill.

Wanted

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

For Sale

BOILERS: (two) 250-hp. Heine water-tube boilers, 150 lb., $950 each; (four) 300 hp. Sterling water-tube boilers, 150 lb., $1100 each; (one) 500-hp. Sterling water-tube boiler, 200 lb., $1750. 110-volt lighting dynamos, General Electric make; 30-kw., $200; 25-kw., $175; 20-kw., $160; 14-kw., $140; 9-kw., $100. Duzets & Son, 50 Church St., New York, N. Y. tf.

FOR SALE—One Lippincott Standard Steam Indicator complete with reducing wheel and all attachments; also planimeter, almost new. Address George Eastwood, Box 164, Kasota, Minn. 1-15-1

FOR SALE—Immediate delivery, one 14¼x28 Buckeye Steam Engine, girder type bed, left hand drive, rebuilt and guaranteed in A-1 condition. BUCKEYE ENGINE COMPANY, Salem, Ohio.

Patents and Patent Attorneys

IMPROVEMENTS WANTED—Send for Free Bulletins listing manufacturers wants and book, "Inventions—Patenting and Promoting." Lancaster and Allwine, 292 Ouray Building, Washington, D. C.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer. Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.-x

PATENTS THAT PROTECT AND PAY — Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill.

Inventions

INVENTIONS commercialized on cash and royalty basis. Inventors and manufacturers should write Adam Fisher Mfg. Co., 2175 Railway Exchange, St. Louis, Mo. tf.

Sparks From The Advertising Pages

An interesting side light on the unmistakable effects of steady advertising and how it works out to the good of both producer and consumer was brought to light recently.

A resident of a Massachusetts town well known for its shoe manufacturing industry was traveling in Germany. This was before the war. He had long ago decided in the affirmative the moss-covered question, does it pay to advertise? but was curious as to the extent of the effectiveness of advertisements which appear with unfailing regularity.

So he decided to make a test. He chose an advertisement of a shoe manufacturer in his own town in Massachusetts. This man was a world-wide advertiser and in his advertisements there had always appeared his own printed face, used presumably, as a trade mark. In making his test the traveler reasoned thus, —"Now if advertising is worth as much as I think it is (and mark you he was not considering direct returns, but rather the cumulative and indirect value of advertising) an envelope with the print of this man's face pasted where the address ought to be should reach the advertiser with little or no delay in transit." Forthwith the envelope was sent with an explanation of the test. There was not a mark of any kind to identify the picture.

What was the result?

The letter went through the hands of postal clerks in Germany—was sent across the water —passed through the hands of U. S. mail clerks and was delivered to the Massachusetts firm in precisely the same time that would have elapsed had the envelope contained the written name and address. The German postal clerks could see by the stamp that it was intended for a foreign country, but to reach the right country and firm without any delay seems to indicate that both German and United States mail clerks were familiar with the printed face and no doubt the products of the advertiser, perhaps having worn out some of them in discharging their duties.

This shows why so many advertisers desire trade-marks that are decidedly individual.

Is there a school-boy or adult who does not recognize at a glance the ebony countenance of the Cream of Wheat Man—the Dutch Cleanser in action—the familiar figures of the Gold Dust Twins—or the little tike representing Fairy Soap, and others too numerous to mention?

And to bring this down to the mechanical field, who among you would not recognize at once the face of the Crane Engineer or the familiar figures of the Perolin Boy or Stephenson's cog-faced man—and such well-known trade marks as Duxbak Belting, Keystone Grease, Cling-Surface, Spartan Belting, Albany Grease and dozens of others.

These are your protection against spurious substitutes.

While we think the test above described was interesting, it is to be hoped that you will not resort to the same scheme—but instead that you will address the envelope just as the signature in the advertisement reads and tell the advertiser that you have seen his advertisement in Practical Engineer. This is a courtesy to the advertiser and one which you should never omit from any of your requests or inquiries.